Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

AUGUST, 1914.

WIRELESS TELEGRAPHY IN AËRONAUTICS.

By BERNARD LEGGETT.

THE advances made within recent years in aërial navigation have led to the necessity for a means of communication between airships and aëroplanes, as well as between them and the Earth.

Although aërial vessels are used to some extent as a new form of sport, their use up to the present for the transport of passengers or cargo has been limited. Their chief use at the present day is for military purposes, such as scouting and the control of artillery fire. An aërial vessel used for these purposes, without an efficient method of communication with its base, is at a considerable disadvantage, since, to impart information obtained during its flight, it must return to its base, which entails loss of time, so that not only is it impossible for its communications to be immediately used, but also the period of its usefulness is curtailed by the time necessary for its flight to and from the base.

Communication might be achieved by semaphores; but this method of signalling is not an ideal one, is comparatively slow, and is possibly useless in the case of aëroplanes flying at high speeds.

The ideal method would be to impart the intelligence by electrical means, and this is only possible by the use of wireless telegraphy.

The installation of wireless apparatus upon aërial vessels greatly facilitates the navigation of the vessel when surrounded by clouds, and permits the aëronauts to receive intelligence regarding their position, the approach of storms, winds, and fogs.

The first attempt to employ wireless telegraphy for aërial purposes was made so long ago as 1898 by Professor Slaby in conjunction with the Prussian Airship Corps. The attempt was carried out with balloons, and it was then found possible to equip these with receiving apparatus only, owing to the small carrying capacity of these vessels and to the fact that wireless apparatus had not then been brought to the perfection obtained nowadays.

Wireless apparatus was also to be employed in the ill-fated Wellman Airship Expedition to the North Pole.

At the present time the majority of the Zeppelin airships is fitted with wireless apparatus, and around the frontier of Germany a series of land stations has been erected (see Figure 287), so that by means of the intensities of the signals received from several stations the position of the vessel may be fixed. These stations are erected upon tall smoke-stacks, and are worked automatically, signals being sent without the constant attendance of an operator. Larger stations are also erected to impart information regarding the weather.

The three most important considerations in the equipment of aërial craft of any form with wireless telegraphy apparatus are the following :—

(1) The question of weight, which necessitates the generating plant and telegraphic apparatus being of exceedingly light construction.
(2) The danger of sparking, causing explosions in vessels of the balloon type.

XUM

FIGURE 277.
Balloon Aërial (Meyerburg).

(3) The entire absence of any method of "earthing" the apparatus. This entails the construction of an artificial earth or counterpoise, consisting of an arrangement of wires with a large electrical capacity extending over an area as large as possible. Such a counterpoise is used for all portable stations, and is also often used for land stations when a good earth-connection in the ground water cannot be obtained.

Since the last requirement necessitates features entirely absent in land stations, we shall consider it in detail.

AËRIALS AND COUNTERPOISES.

The natural position for the aërial of a flying vessel is for it to hang below the passenger cage. As the aërial, if permanent, would be an impediment to the navigation of the vessel when flying low, tending to become entangled in trees, and so on, it must be capable of being quickly lowered or wound up. Further, to guard against the possibilities of its becoming entangled, with dangerous results, it must be made capable of only being able to withstand a moderate tension, so that it may become automatically detached if necessary.

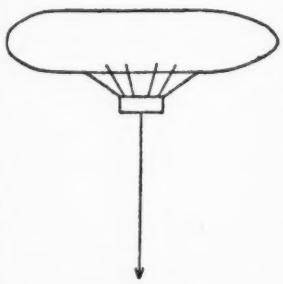


FIGURE 278.
Balloon Aërial.

The aërial wire is usually made of phosphor bronze, and is wound upon a winch. At its lower end it carries a plumb bob to keep it taut when unwound, and to cause it to unwind quickly when required. In the case of airship stations, this winch is above the telegraphic apparatus, and is fitted with mechanism to indicate the length unwound. It is also coloured in different lengths, corresponding to the lengths suitable for the fixed wave-lengths for which the transmitting apparatus is designed. In the case of aëroplanes, the winch is near the telegraphist. Such a winch is shown in Figure 281, where the leaden plumb bob may be seen, and also a brake to operate the winch. The aërial is conducted away from the neighbourhood of the propeller and other revolving parts of the vessel by a copper tube to ensure that it does not become entangled with these, which would naturally cause fatal results. The wire is also jointed at distances of five metres, so that if entangled with the Earth it may break off when the tension amounts to from five to ten kilogrammes. Often a special device is fitted which automatically cuts the wire when the tension exceeds the normal tension. The aërial is in electrical contact with the winch.

The counterpoise, in the case of balloons, is composed of the metal parts of the passenger car (see Figure 278). Where the capacity of this is not sufficient, a conducting net passing completely round the gas bag is provided, as in Figure 277. This form of counterpoise is due to Meyerburg (D.R.P., No. 232257), and has the advantage that it not only gives a very large counterpoise, allowing a very long aërial to be used and long ranges to be obtained with comparatively small generating plant, but that it effectually protects the gas bag from the sparks caused by natural electrical discharges, which often lead to fatal accidents.

Dr. Beggerow has also patented (D.R.P., No. 225204) a form of aërial shown in Figure 279. Here the counterpoise is obtained by hanging two wires, one of which is much longer than the other, both being in metallic connection so far as length permits. The jointed portions form the counterpoise while the extra length of the longer wire forms the aërial.

This method gives a very efficient aërial, and also ensures all high-tension wires being removed from the neighbourhood of the gas bag.

The form of aërial adopted upon the Zeppelin airships is as shown in Figure 280, and is due to Professors Braun and von Sigsfeld. It is highly directive in the vertical plane through the length of the gas bag.

The counterpoise is formed by the two vertical wires and the aërial by the horizontal wires in the case when the former wires have each a length of $\frac{1}{4}\lambda$ and the latter a total length of $\frac{1}{2}\lambda$. Various wave-lengths are obtained by the insertion of self-inductance coils in the horizontal wires, and by lowering or raising the vertical wires to the requisite extent.

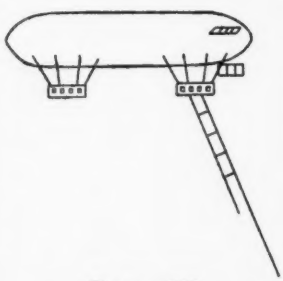


FIGURE 279.
Airship Aërial (Beggerow).

In the case of aëroplanes, the counterpoise is obtained by means of the propelling motor, cooler and other metallic parts, and by use of the stays, these being increased if necessary.

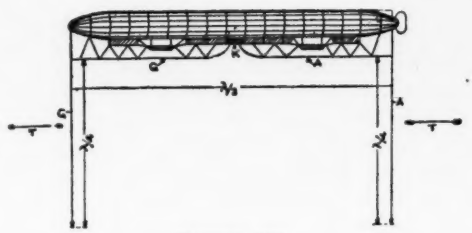


FIGURE 280.
Directive wireless aërial of a Zeppelin Airship.

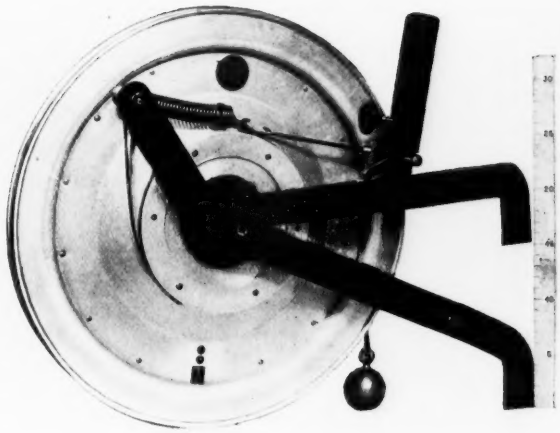
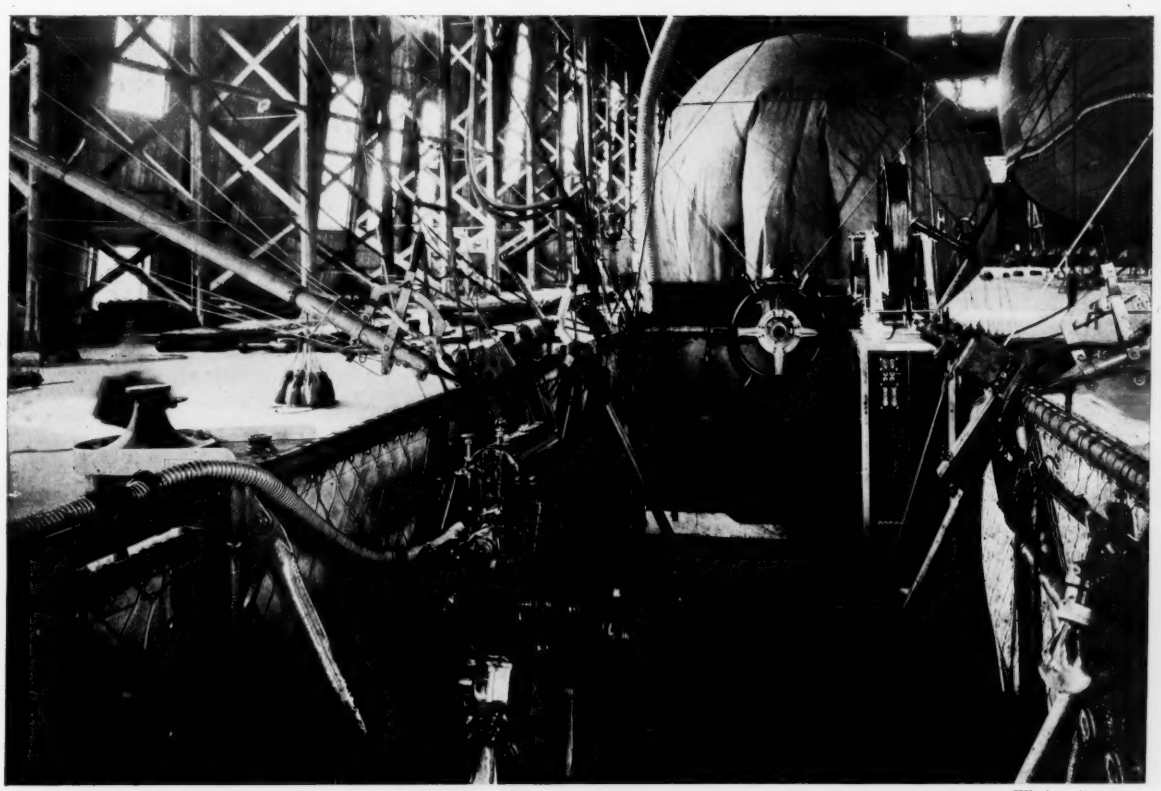


FIGURE 281.

Aëroplane wireless aërial Winch, showing brake.

FIGURE 282.

Aëronaut's Silence-helmet with built-in telephone for the reception of wireless signals.



Generating Plant. Wireless Apparatus.

FIGURE 283.

Arrangement of a wireless installation in the interior of a Zeppelin Airship.

XUM

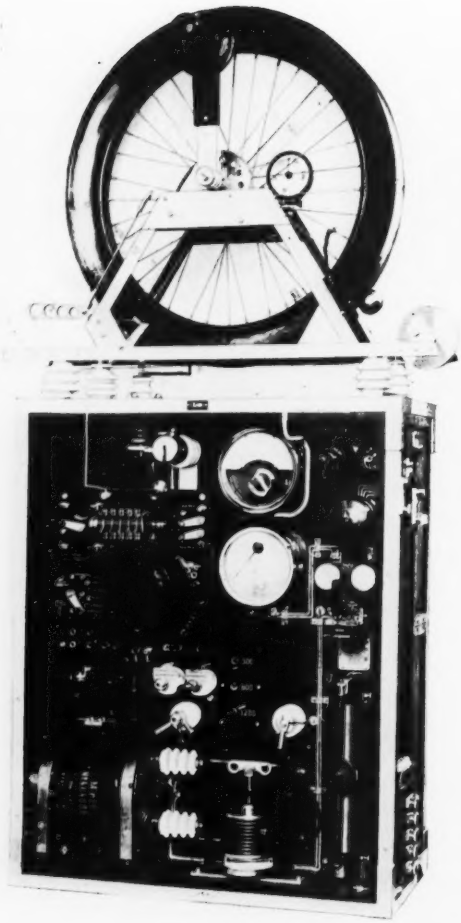


FIGURE 284.

Airship Station, showing spark gap, transformer, Morse key, aërial ammeter, and receiver, with aërial winch above.

Spark Gap.

FIGURE 285.

Large Aëroplane Transmitter and Receiver.

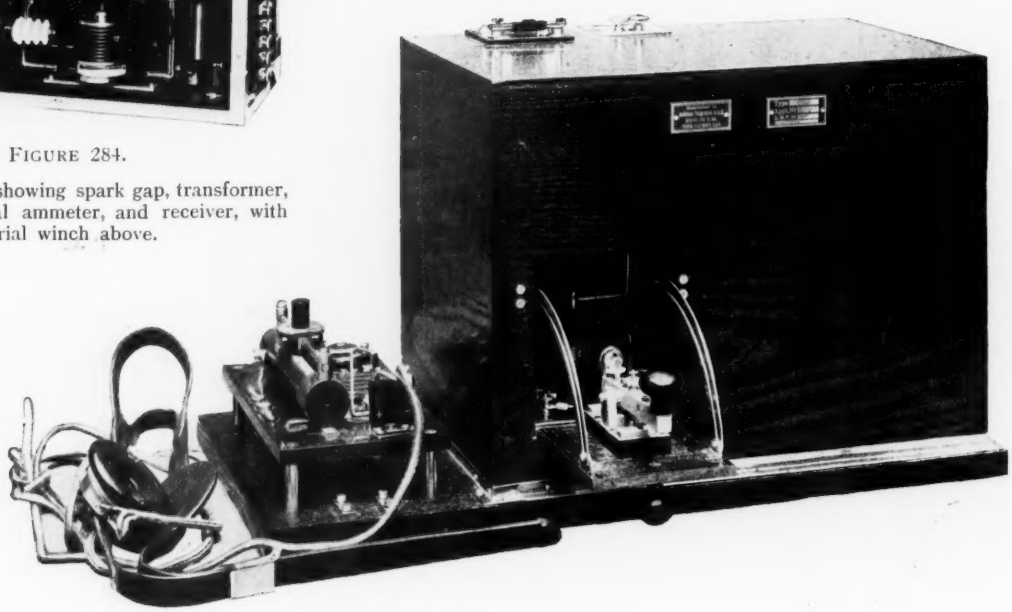


FIGURE 286.

Small Aëroplane Wireless Station.

AËROPLANE STATIONS.

Two stations for aëroplanes are made by the Gesellschaft für drahtlose Telegraphie, or "Telefunken" Company.

The smaller station is for the smallest type of aëroplanes, or for balloons, which direct the fire of an artillery battery, for which purpose a range of about twenty-five kilometres is ample.

This station is illustrated in Figure 286. The wooden case contains the complete transmitting apparatus with the exception of a battery of cells or accumulators which supply the necessary power. The current is transformed to the necessary high tension by means of a hammer-break induction coil inside the case. The only connections required for transmitting are those between the aërial and transmitter and transmitter and counterpoise, these connections being made by means of the terminals seen at the top of the wooden case.

In the front wall of the case is seen a small trap upon which the Morse key is fixed. Regulation of the coupling between the aërial and the primary circuit, as well as variation of the self-induction of the aërial lengthening coil, is obtained by means of two hand wheels outside the case. If required, these hand-wheels can be adjusted simultaneously. Near the aërial and counterpoise terminals can be seen a helium tube, which indicates resonance between the primary and secondary circuits.

Upon the base-plate of the transmitter is arranged the receiver. This is also connected to the aërial and counterpoise by means of plug-sockets. Upon this receiver-plate is a sliding coil for tuning the aërial. A detector and telephone are in parallel with this coil, the telephone being shunted across a blocking condenser. The telephone is built into a padded helmet, illustrated in Figure 282, in order to deaden the noise due to the aëroplane motor. The total weight of the station is about twenty-five kilogrammes.

The larger station is not dependent upon batteries, but is worked by an alternator driven by the aëroplane motor. This station radiates 1 kilowatt of electrical energy. Its total weight, including the aërial, is from forty to fifty kilogrammes, and its range is about 100 kilometres. The installation is intended for aërial scouting purposes.

The small five-hundred-period alternator, working at three thousand revolutions per minute, is geared to the propeller shaft of the aëroplane, this working at from one thousand one hundred to one thousand two hundred revolutions per minute. A clutch is provided, so that the motor can be quickly started or stopped from the telegraphist's seat. This alternator generates about ·2 kilowatt at one hundred and ten volts. It is excited by means of a small direct-current generator directly built upon the rotor. Regulation of the exciting current is obtained by means of a sliding resistance.

The one hundred and ten alternating current is transformed to eight hundred volts by a transformer, and charges a single mica condenser, the capacity of which is appropriate to the aërial used. The spark gap consists of several quenched spark electrodes separated by mica discs, which may be seen in Figure 285. As a primary inductance a flat copper spiral is used in series with a small cop per variometer, which serves to tune the primary and secondary circuits. The primary circuit is designed for the three fixed wave-lengths of three hundred, four hundred and fifty, and six hundred metres.

The secondary circuit consists of the aërial and aërial lengthening coil, the latter being marked for the wave-lengths given above. The connection for any particular wave-length is made by a switch common to both circuits. Resonance between the circuits is indicated by maximum reading of a hot-wire ammeter.

The receiver is built into the upper part of the apparatus cabinet, and a change-over switch making the necessary connections for receiving or sending is provided.

Variation of wave-length for receiving is carried out by means of a cylindrical sliding coil which is in parallel with a detector and a one thousand-ohm telephone, the latter being shunted across a blocking condenser in the usual manner. Duplicate detectors are provided, either of which may be put in circuit by means of a small detector switch, and during transmission both detector circuits are broken, to guard against damage to them. The wave-range of the receiver, with an aërial eighty metres in length, is from three hundred to nine hundred metres. The telephone is built into a heavily padded helmet, similar to that shown in Figure 282, to deaden the noise of the aëroplane motor.

THE AIRSHIP STATION.

The apparatus of which the airship station consists are mounted in a wooden cabinet, which is divided by means of a vertical partition into an open front section and a closed back section.

In the front open half (shown in Figure 284) are all the separate parts of the transmitter and receiver which have to be operated or adjusted by hand, while the back closed half of the cabinet contains all those parts of the transmitter which need no attention, such as the self-induction and capacity.

The aërial winch is mounted on four porcelain insulators on the top of the cabinet. On this winch a phosphor bronze aërial wire three millimetres in diameter and about two hundred metres long is wound. The wire is wound off by means of the insulated hand crank to suit the wave-length chosen, a counter showing the number of metres paid out. The wire passes over insulated pulleys over the edge of the car and hangs down freely. The crank, pawl, brake, counter, and drum of the winch are heavily insulated. Outside the cabinet on the right-hand side are the terminals for the connections from the source of power and for lighting the station. The external dimensions of the cabinet are: Width

about sixty centimetres, depth about thirty-three centimetres, and height about seventy-six centimetres, and the station requires a vertical space of about one hundred and thirty-five centimetres.

An aërial change-over switch, in the cabinet, is arranged so that when in the transmitting position it interrupts the receiver circuits, and when in the receiving position interrupts the main-power circuit, so that the sensitive receiving apparatus is not liable to be damaged by accidental pressing of the key while receiving. The metal frame of the car forms the counterpoise.

The source of power is an alternating current generator with direct-coupled exciting machine. The output of the generator, at about three thousand revolutions per minute is about 500 watts, and the frequency is five hundred cycles per second. The generator is driven from the motor of the airship either by means of a belt or chain, or by means of intermediate gearing with a throw-out clutch.

A voltmeter and a pressure-speed regulator and the necessary fuses are mounted in the cabinet.

The transmitter consists of the following:—Transformer, quenched spark gap, excitation capacity and self-induction, aërial lengthening-coil ammeter, Morse key, and a changing device for three different wave-lengths.

The excitation circuit of the transmitter can be tuned to several waves, ranging from three hundred metres to six hundred metres, but if the airship is flying very low down only the short wave-lengths can be used. For the different wave-lengths corresponding aërial coils, fitted with connecting plugs for specified wave-lengths, are connected in the antenna. Exact tuning is effected by winding off more or less of the antenna wire. The latter is marked with different colours corresponding to the connections on the excitation and coupling coils.

The receiver is a complete aural receiver of a special type designed for airships. The separate parts of the receiver are as follows: Variable self-induction, detector, telephone, blocking condenser, and a blocking switch for the detector. Plug sockets are provided for two telephones. All these parts are mounted in the cabinet.

The whole of the self-induction which is used for increasingthe natural wave-length of the aërial is also used for direct coupling the detector. The detector coupling turns can be varied by means of plugs. The number of turns for lengthening the aërial remains approximately constant for all wave-lengths, so that only the detector coupling turns need to be regulated.

The effective range of the station communicating with a wheeled military station is from one hundred to two hundred kilometres.

The weight of the complete station is about two hundred and seventy-five pounds, the alternator weighing one hundred and twenty pounds, and the apparatus cabinet and winch one hundred and fifty-five pounds. A similar but larger installation, radiating ·3 kilowatt of electrical energy, is also manufactured. The installations described are all built upon the Quenched Spark system; and since this form of spark gap radiates from fifty per cent. to seventy-five per cent. of the primary energy, these stations be may regarded as the lightest and most efficient aërial stations yet manufactured.

SOCIETIES.

THE LONDON ASTRONOMICAL SOCIETY.—A meeting of the above Society was held on Saturday, July 18th. Mr. Worthington gave an address on the probability of life on Mars. He showed that the Polar caps could be composed of nothing other than water substance. He also showed that it was impossible for water to reach the equatorial regions of the planet by any natural means. He came to the conclusion that it was artificially conveyed there. He repeatedly saw canals on Mars during his recent visit to the Flagstaff Observatory, which confirmed his previous observations.

The President, Professor A. W. Bickerton, concluded the meeting with an address on the Progress of Science and Cosmic Evolution.

THE AMERICAN ENTOMOLOGICAL SOCIETY.—The American Entomological Society being desirous of bringing its publications more promptly before entomologists who are not situated near the larger reference libraries, or who desire to build up special entomological libraries of their own, has devised a scheme by which a mutually beneficial coöperation can be secured.

Its Transactions are now beginning Volume XL, and their pages contain papers covering the whole field of entomological activity, aside from purely economic problems now covered by Government support, papers on the general subject appearing, as well as numerous special studies in the various orders.

The price of subscription to the complete volume of the Transactions is four dollars—payable in advance—the issues appearing approximately quarterly. The last two volumes (XXXVIII and XXXIX) of the Transactions contained seven hundred and thirty-four pages and twenty-nine plates. All of the receipts of subscriptions and sales on account of publications are used in maintaining and enlarging the Transactions and such other publications as the Society brings out, so that all funds received from these sources are used solely for the support and betterment of the journals, the subscriber being the one directly benefited.

The Society also sells separates of the various papers published by it, the price for which is computed on a fixed basis per page and plate, this price being known as the list price.

The Society proposes to enable workers who may not wish for the whole Transactions to subscribe to the separate papers on such orders as interest them. In doing this, it offers a reduction of ten per cent. from the list price to those subscribing to all papers in one or more orders, the payments being due on receipt of the publications.

As an alternative proposition for interested workers who may not wish to secure all the papers of certain orders, but who wish to be in touch with such as are appearing, so that they can secure promptly those they do desire, the Society will send notices, consisting of an abstract of the paper with price, to those who desire such notification.

Particulars can be obtained from the Publication Department, 1900, Race Street, Philadelphia, Pa., U.S.A.

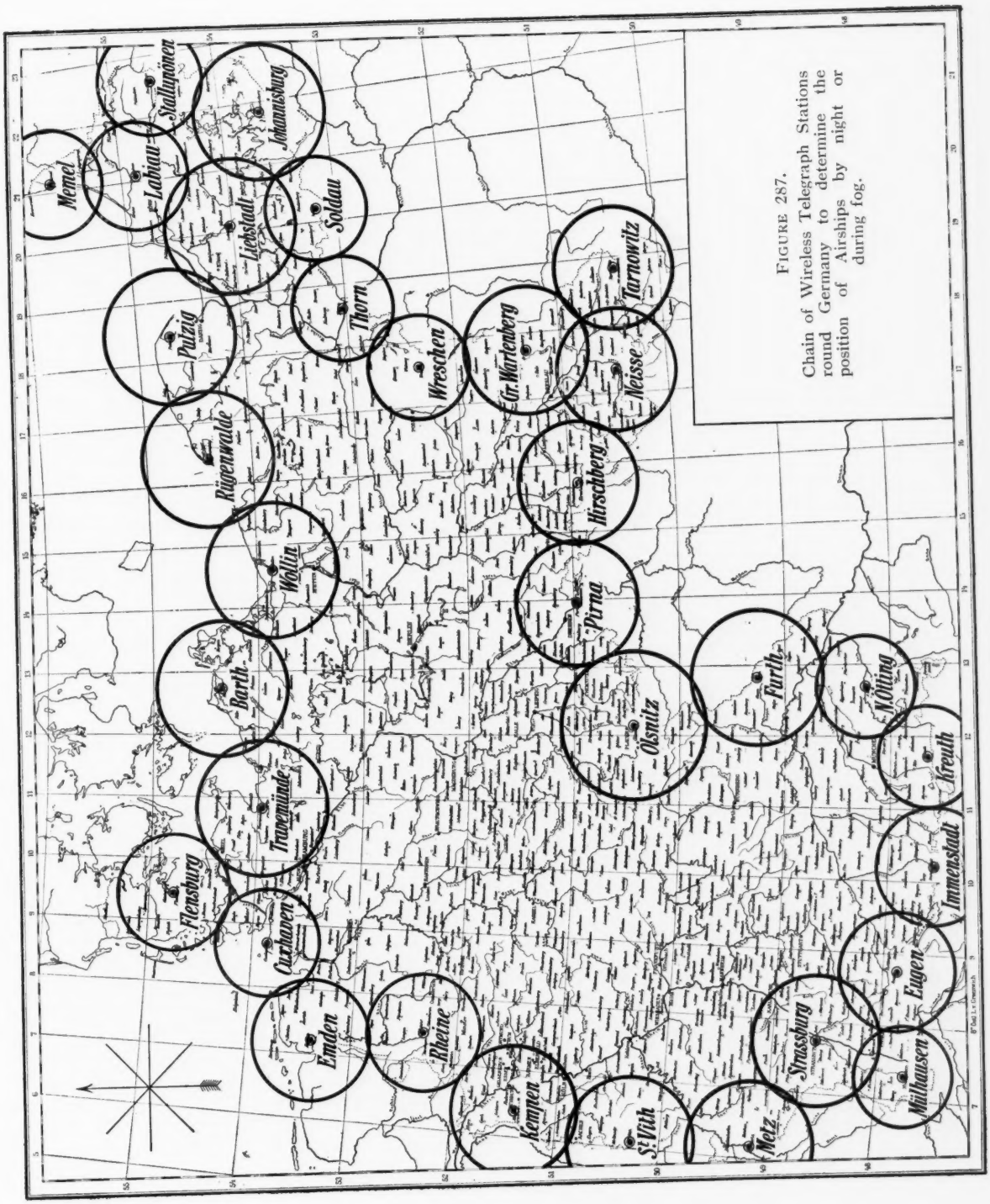


FIGURE 287.
Chain of Wireless Telegraph Stations round Germany to determine the position of Airships by night or during fog.

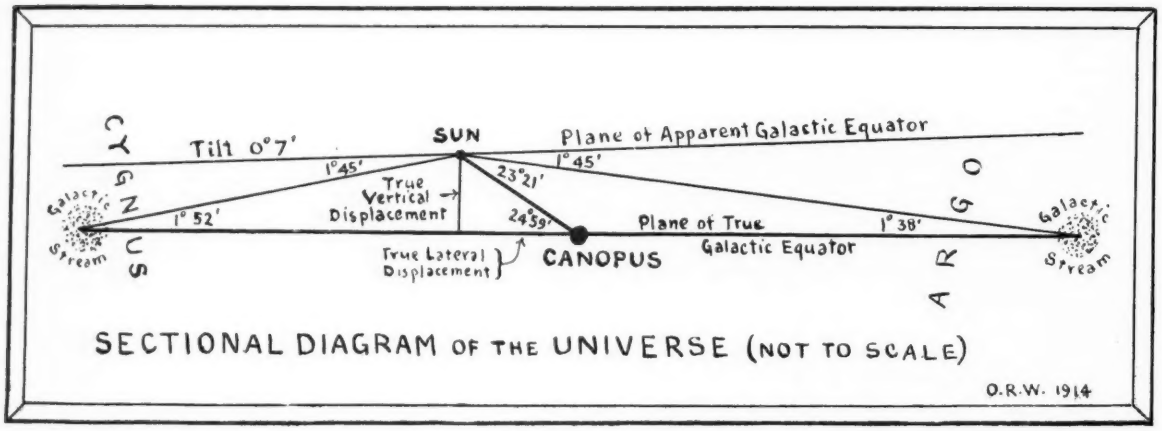


FIGURE 288.

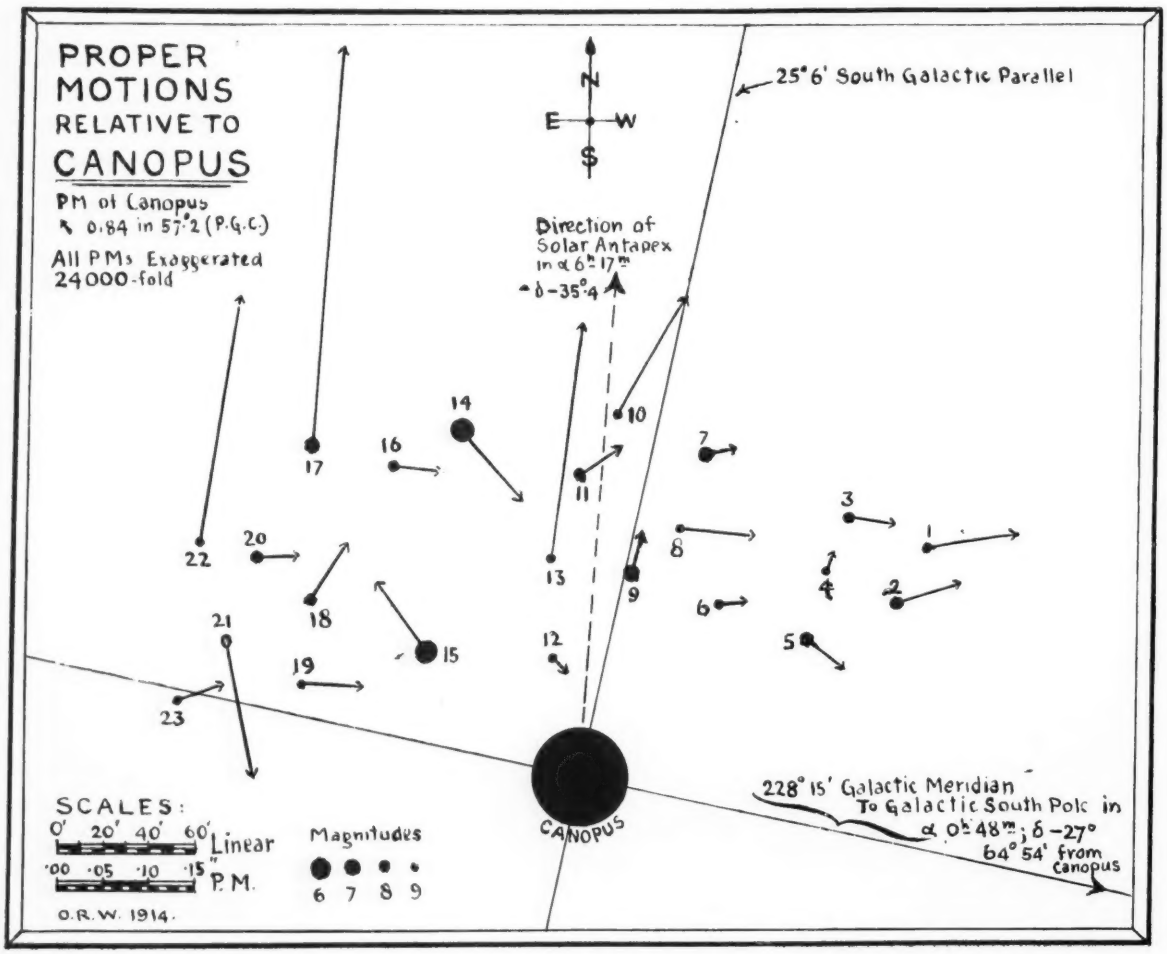


FIGURE 289.

THE SIDEREAL CENTRE.

By O. R. WALKEY, F.R.A.S.

THE Helium or B type, the so-called " Orion," stars are those which recent studies concur in placing at great distances from our system, while their brighter members, too, appear, according to Professor Campbell (*Lick Obs. Bul.*, 195) to lie as fully remote as do their fainter. This peculiarity, together with the rapid decrease, with diminishing magnitude, in the numbers of this class, argues a great average luminosity, coupled with great distance. Further, these stars are found by Professors Campbell and Boss (*Lick Obs. Bul.*, 195; *Astron. Journ.*, 620, 635-6) to be virtually free from that preferential motion, or star-streaming, which seems to be characteristic of the other spectral classes. These stars thus peculiarly invite treatment as of those most truly representing the visible universe, of which they may not unfairly be regarded as the framework.

In a recent study by the writer (*Mon. Not. R.A.S.*, May, 1914) of the distribution of the several spectral classes—particularly of type B—with reference to the galaxy, the relative preponderances of these stars (Oe5 to B5) in galactic latitude and longitude respectively places the apparent centre of their system on the 230° galactic meridian—or of " galongitude," reckoned from the intersection of the galactic and celestial equators in Aquila—and between 20° and 30° south in galactic latitude, or of " galatitude." This, in other words, is the direction from which our solar system appears to lie eccentric within the universe defined by the helium stars. The relatively small number (seven hundred and six) of these stars involved (as given in *Harvard Annals*, Vol. 56, pt. 2) is largely compensated by the generally remote and therefore comprehensive distribution just referred to of this type's brighter members, of which this number is largely composed, and includes them all. The sidereal centre probably lies, therefore, on the line just named, or between α 6h 0m, $\delta - 55°$, and α 6h 55m, $\delta - 52°$. The same studies with the work of Kapteyn, Boss, and Campbell further indicate the distance of this centre as being in the neighbourhood of four hundred light-years, or one hundred and forty " secpars," to adopt under this name the more useful unit of stellar distance corresponding to 1″·0 parallax.*

The association of a particular star with the sidereal centre would, if established, give coherence to the several lines of study now proceeding in stellar motion and distribution, and enable us to realise more clearly their true significance. Accepting the position line defined, it will be found to lie nearly symmetrically across the splendid star Canopus, and the only star within the prescribed limits of which we have any definite knowledge. This star appears to be the greatest sun of which we know anything, and is referred to by Professor See as an example of his hypothesis of condensed star-clusters. In view of this remarkable coincidence the further study of this star assumes a peculiar interest as pertinent to the question of a sidereal centre.

Firstly, as to the distance of Canopus:—the late Sir David Gill found its parallax and proper motion to be insensible with regard to four 8th-magnitude comparison stars, of which the average absolute parallax, according to Professor Kapteyn's table (*Gron. Pub.*, No. 24) is ″·0065. Considering, however, the uncertain application of averages to individuals, further evidence is desirable in support or otherwise of this value, and is best afforded by a study of the cross and radial motions in relation to the solar motion in space. The speed of solar motion and its apex appear to vary slightly, according to the spectral class of the stars to which they are referred. Here, as for their general fixity, the helium stars are the chosen reference for the solar position, so in consistence to them also should the direction and speed of solar motion be referred. Professor Boss (*Astron. Journ.*, 623-4) has derived the solar apex relative to four hundred and ninety of these stars alone, the mean of his two solutions placing the apex in α 18h 17m, $\delta + 35°{\cdot}4$ (assuming a solar velocity of twenty kilometres a second); while Kapteyn, Campbell, and Stroobant (assuming apices derived from all spectral types, and but little removed from Boss) derive from the B stars solar velocities ranging from 20·7 to 23·3 km./sec.; the mean of these (weighted according to the numbers of stars used) is 21·5 km./sec., and is here adopted with Boss' Apex, of which the antapex lies therefore in α 6h 17m, $\delta - 35°{\cdot}4$, a point found to lie 21° 9′ south in galatitude (referred to Newcomb's mean north galactic pole in α 12h 48m, $\delta + 27°$). The antapex further lies 17° 15′ northward from Canopus, the speed of apparent or parallactic drift of which (due to the solar motion) becomes 6·37 km./sec. towards this

* The name here adopted is the proposed "parsec," with the syllables reversed to meet the objection lately raised to its implication (by English usage of final syllables) of time or pure arc rather than distance.

antapex. The corresponding radial component (recessional) set up in Canopus is 20·53 km./sec., a figure which almost exactly coincides with the observed velocity of Canopus, 20·6 km./sec. in recession. This indicates Canopus to be stationary with regard to the universe defined by the B type stars.

The annual proper (cross-) motion of Canopus, according to Boss ("Prelim. Gen. Cat."), is ″·0184 in the direction 57°·2, or at 60°·4, with the direction of the solar antapex, whither the parallactic component is therefore ″·0091, while the normal to this line is ″·0160. Taking the parallactic component to represent the parallactic speed previously derived, the absolute parallax of Canopus becomes ″·0067. Apart from the inherent uncertainties of these small quantities (considering, too, Gill's failure to detect proper motion), this figure may be affected in either direction by the component of any real motion which Canopus may have crosswise towards or away from the antapex. The absence, however, of peculiar radial velocity argues the probability that any peculiar motion may be entirely absent, and in any case its crosswise component should not be large enough to affect materially the derived parallax. If, on the other hand, we accept the reality of peculiar motion, there is an hypothesis which is strongly supported by the A type stars, and which may be mentioned, of motion parallel to the galactic plane as brought out by Professor Campbell and applied by Professor Plummer. This hypothesis usually supplies a good criterion of the distance of an A type star. Since Canopus, however, belongs to type F, a class which affords no definite evidence of galactic planar motion, the application of this method fails, as is evidenced, too, by the parallax (″·077)* so derived being inadmissibly large in the face of Gill's careful measures.

The peculiar motion (if any) of Canopus would therefore be at random, in which case it may be used in two ways, according to the assumption involved, to derive the parallax. Assuming (i) Boss' average ratio (*Astron. Journ.*, 614)

$$\frac{\text{parallactic motion}}{\text{whole motion}} = 0{\cdot}7$$

to apply in this case, the resulting parallactic motion (″·0129) yields, with the parallactic speed, an absolute parallax of ″·0096, or a distance of one hundred and four secpars; (ii) that the speed of motion peculiar to this star be 15·3 km./sec., the mean of Campbell's (14·4) and Boss' (16·2) values derived for the F stars, in which case the parallax becomes ″·0050, giving a distance of two hundred secpars. The mean parallax on these two assumptions becomes ″·0073, while the mean by distances is one hundred and fifty-two secpars. Though probably neither of these assumptions is true, yet, being independent and complementary, the truth, in the event of peculiar motion, should fairly lie between them, so that their mean result may be taken as a further index of the distance, and is in striking agreement too with the two previous estimates as the tabulated results show.

DISTANCE OF CANOPUS.

Estimate by	*Parallax.*	*Distance.*
Comparison Stars	″·0065	154 secpars
Parallactic Motion	·0067	149 ,,
Whole Motion ...	·0073 (by mean)	152 ,, (by mean)

In view of the excellent agreement of these entirely independent estimates, the distance of Canopus may fairly be assumed to be one hundred and fifty secpars, a figure which agrees well too with the order of distance derived for the sidereal centre.

As to the luminosity of Canopus, the R.H.P. magnitude is −0·86, while that of our Sun, if removed to a distance of one secpar, may be taken as 0·0 (implying an actual stellar magnitude −26·57); thus Canopus is actually forty-nine thousand seven hundred times as luminous as the Sun, while its spectrum is class F. Professor Russell and Dr. Shapley have derived from the known binary systems the surface brightnesses of the several spectral types, and which should (they state) be fairly constant for each type. They find the surface brightness of the F stars to be 1·1 magnitude, or 2·75 times brighter than the solar (and with a temperature of 7500° against the solar 5000° C.). The area of Canopus thus becomes eighteen thousand, the diameter one hundred and thirty-four, and the volume two million four hundred and twenty thousand times those respectively of the Sun. Russell and Shapley further find that, on a diagram of surface areas (derived from absolute magnitude with unit surface brightness) for different type stars of unit (solar) mass, the F stars segregate compactly just one magnitude larger than our unit Sun, whence follows a relative density $\frac{1}{(2\cdot512)^{\frac{3}{2}}}$, or 0·25 the solar. Applying this to the bulk of Canopus, its mass becomes six hundred and nine thousand times the Sun's. The chief uncertainty in these values lies in the actual density of such a great sun as Canopus manifestly is. The mutual attraction of so large a volume of gas thus presented would give rise to a set of conditions surpassing anything with which we are acquainted; the tendency, however, should be to increase the density and consequently the mass, of which therefore six hundred thousand times the Sun may be

* Using the general values of solar motion and its apex, as used by Plummer, the parallax reduces to ″·032, a value still too large, however.

fairly set down as the lower limit.* A previous estimate, by the late Mr. Gore, of the Canopic mass, based on a parallax of ″·01, from comparison with Procyon (F5 spectrum), made it a million times the Sun. This estimate, though agreeing well with the present one, rests on one star alone, and that of a spectrum not exactly similar.

Given such a mass, its effect should be evident in the relative motions of the faint stars amongst which it is situate. In order to apply some such corroborative test, a region was chosen extending from 6h 4m to 40m in R.A., and from 50° to 55° in south declination, representing an area some five degrees square around Canopus, and all the stars of the Cape and Sydney astrographic catalogues within these limits were plotted. The proper motions of those in the southern belts (below −52° and allotted to Sydney) are, unfortunately, not reduced, so that only those (Cape) stars between −50° and −52° having assigned motions† appear in Figure 289, supplemented for brighter stars from Boss' "Preliminary General Catalogue." Figure 289 consequently shows twenty-three stars (numbered in order of R.A.) in the northern vicinity of Canopus, to which their cross-motions have been reduced relative. Resolving these tangentially and radially, and reckoning their components positive according as they are respectively clockwise around and away from their primary, the mean tangential component is found to be ″·0505 (clockwise) as against ″·0344 (outward) mean radial motion. Of the tangential components only two are negative and one zero, while their stated mean represents eighty-three per cent. of the mean whole motion. This, coupled with the fact that the negative radial components confine themselves to one side (west) of their primary, appears to afford evidence of orbital motion enough to justify a closer study in weeding out any stars plainly extraneous to any presumable sub-Canopic system. An inspection of Figure 289 will eliminate Nos. 10, 13, 17, and 22, as having large proper motion, and apparently sharing the drift of the more rapid of Kapteyn's two-star streams (that towards α 90°, δ − 12°), their large p.m. arguing a common greater proximity to our system. On this score No. 21, with ″·15 in the opposite direction, should also be excluded.‡

The relative motions of the remaining eighteen stars, as of those at presumably the same order of distance, will remain unaffected by the component of solar motion, and, as possible satellites to Canopus, present the following quantities, which have been derived as simple means as sufficiently approximate, considering the inherent uncertainties of our data:—

CANOPIC SYSTEM.

Mean distance from Canopus...	D	133′·1
Mean tangential component (clockwise) ...	T	″·0341
Mean radial component (outward)	R	″·0042
Mean inclination to radius-vector $\tan^{-1}\frac{T}{R} = \theta$		83°·0
Minimum mass (times the Sun)		794,000

The angle θ expresses in its approach to 90° that towards the condition of satellites symmetrically placed in a common orbital plane, or of circular motion in a plane normal to the right line. This latter case, if true, would represent the minimum mass $M = DT^2$ when at a distance of one hundred and fifty secpars, D represents one million two hundred thousand astronomical units, and T fifteen miles a second, or 0·81 of the Earth's mean orbital speed. This mass and that previously derived depend alike on the adopted distance of Canopus, of which their mutual relation is consequently independent. Though necessarily provisional, the striking agreement—after due allowance for coincidences—of the two entirely independent estimates of the minimum mass constitutes a somewhat forceful case for the reality of orbital motion for the faint stars in the vicinity of Canopus. This of course cannot be accepted as fact until we have the evidence of such stars of the −52° to −55° belt in the southern vicinity of Canopus, as may reasonably lie at the same distance. The reduction of these motions is therefore highly desirable, as invested with a peculiar interest.§

There is in this connection one point to be observed, namely, that "forward" orbital motions distributed in all planes around their primary will appear "forward" or "retrograde" according as their stars lie on the near or far side of their primary. The settlement of the question thus awaits the development of appliances able to measure the radial velocities of these faint stars.

The actual mass of Canopus will be anything greater than the figure derived, according to the

* One source of uncertainty, that affects some of the quantities derived, is the adopted stellar magnitude of the Sun. Russell adopts one 0·3 magnitude brighter, evidently following the Harvard reduction −26·83. Substituting this for the (unital) −26·57 figure, the luminosity of Canopus reduces to the actual value 39,100, the area to 14,200, diameter to 119, and bulk to 1,691,000 times these solar quantities; the density, on the other hand, increasing to 0·36 the solar, leaves the mass unchanged, and independent therefore of the adopted stellar magnitude of the Sun.

† The four comparison stars used for determining the parallax of Canopus are excluded as being assigned no motion, their mean motion being indistinguishable from that of their primary; a result to be expected in the case of more or less symmetrically placed "satellites," if such at all.

‡ Other stars, such as Nos. 1, 14, and 15, might further be omitted; such exclusion, however, is scarcely warranted in view of the uncertainties of small p.m.'s, while their exclusion effects no appreciable change in the resultant quantities.

§ The two stars of known p.m. in this region, δ Pictoris (4·8 magnitude) and G Carinae (4·4 magnitude), have nearly equal and parallel motions (counter-clockwise), which implies a common drift and considering too their brightness, and being only two in number, they supply no real criterion.

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mean orbital inclination (i) to the line of sight.* The most reasonable index as to this will follow from the assumption of random orbital inclination, whence integrating $\sin^3 i$ (by the inverse of which the mass varies) gives a mean value ·589: this, divided into the minimum mass, gives one million three hundred and fifty thousand times the Sun as the probable actual mass of Canopus.

A curious result which follows from this is that such a mass, acting at one hundred and fifty secpars, would of itself produce in our Sun's motion a tangential component of 3·86 miles or 6·21 kilometres a second. When we consider that the actual crosswise component of solar motion is 6·37 km./sec., the striking agreement, which it seems hard to believe entirely coincident, impresses itself in confirmation of the foregoing hypothesis. Again, this agreement of the estimate with the fact supplies an indirect confirmation of the distance of Canopus, since this is ultimately a direct function of the velocity.†

The mass necessary at one hundred and fifty secpars to produce the actual crosswise solar component would be one million four hundred and twenty thousand Suns. The close agreement of these estimates implies that the combined attraction of the lesser suns around us is balanced in this respect—a state of affairs which, if continuous, would indicate for our Sun a highly eccentric hyperbolic orbit in a plane nearly perpendicular to the celestial, and having its "outer" focus distant one hundred and sixty secpars in the direction α 6h 14m, δ − 18° 10′ (a degree west of β Canis Majoris), towards which point, therefore, the solar antapex would imperceptibly shift with the lapse of time. As a matter of curiosity—for it assumes continued absence of disturbing forces—the elements of the hyperbola derived are given as follows:—

Eccentricity	8·52	
Angle between asymptotes ...	166½°	
Direct axis	10·9	secpars; inclined 13° to galactic plane
Conjugate axis	92·3	secpars; inclined 23° to galactic plane
Parameter	780	secpars; inclined 23° to galactic plane
"Perihelial" distance ...	41·0	secpars
Epoch since "periastral" passage	219×10^{12}	years

Needless to say, the final item is imaginary of the present creation being then existent! The angular divergence of the asymptotes indicates (in its supplement) that the ultimate deviation of the solar path due to Canopus is thirteen and a half degrees from the straight line.

The several indications in favour of the present hypothesis may now be summarised as follows:—

(i) Canopus occupies the approximate position derived for the centre of the stellar system, as defined by the remote helium stars.
(ii) Its distance is of the same order as that indicated for this helium star centre.
(iii) Canopus appears to be stationary with reference to these virtually "fixed" helium stars.
(iv) Its predominant luminosity and mass are in character with their suggested significance.
(v) The relative motions of the faint stars, so far examined, in the vicinity of Canopus indicate an orbital motion confirming the independently derived mass.
(vi) The component of solar motion tangential to Canopus indicates the existence of such a mass at the given distance.

Two other features, which may prove relevant, are:—

(*a*) The objectives (α 90°, δ − 12° and α 263°, δ − 60°) of Kapteyn's two star-streams (assuming their reality) lie on either side of Canopus at angular distances inversely proportional to their respective speeds, and in nearly the same apparent south galatitude as Canopus.‡
(*b*) The solar antapex lies in nearly the same apparent south galatitude.

It will, of course, be clearly understood that none of the foregoing indications are set forth as in any way *proving* the central position of Canopus, the indication in some cases being within its own limit of error. They nevertheless point consistently in the same direction, though mutually independent, so that, however slender may be each cord in itself, yet, collectively, they assume that comparative strength which the cable bears to its component strands. As a chain of mere coincidences in a common direction, the foregoing indications would be scarcely less remarkable than the fact it is suggested they demonstrate.

Finally, the central position of Canopus may, if established, be used to determine the galactic distances in terms of the Sun-Canopus line, which would thus serve for the sidereal system the purpose served by our astronomical unit (Earth-Sun line) for the solar system. The diagram in Figure 288 exemplifies the principle, while the table summarises the resultant distances relative to the unit line, and absolutely in secpars and light-years. The quantities follow from the apparent southward deviation 1°·75, derived by the late Professor Newcomb for the main galactic stream in connection with the apparent south galatitude 25°·1 of Canopus,

* For instance, suppose all the companion stars to lie in the true galactic plane, and therefore inclined at 25° to the sight line, the actual mass would then be:

$$\frac{\text{minimum mass}}{\sin^3 i} = \frac{794{,}000}{\cdot 08} = 9{,}920{,}000 \text{ Suns.}$$

† Velocity $\propto \sqrt{\frac{\text{mass}}{(\text{distance})}}$; mass $\propto$ (distance)^3, whence velocity $\propto \sqrt{(\text{distance})^3} \propto$ distance.

‡ The galactic meridian of Canopus bisects the remarkable assemblage of helium stars in a belt 10° wide between 200° and 260° in galongitude, and comprising about a quarter of the present count for the whole sky.

relative to the plane having its N. pole in α 192°, δ + 27°.*

GALACTIC DISTANCES.

Quantity.	*Unital.*	*Secpars.*	*Light-years.*
Sun to Canopus	1·00	150	489
To Galaxy in Cygnus ...	12·98	1950	6330
To Galaxy in Argo ...	14·80	2220	7220
True Galactic Radius ...	13·88	2080	6780
Vertical Displacement of Sun	0·422	63·3	206
Lateral Displacement of Sun	0·906	136	442

Our eccentricity within the galaxy is therefore vertically $\frac{1}{33}$ and horizontally $\frac{1}{15}$ of the galactic radius, while the figure derived for this radius, corresponding to a parallax of ″·0005, follows the trend of recent indications by other methods.

While considering the distance of the galaxy, an independent and rough index of this is supplied from the average actual luminosity in terms of our Sun of the Type II (F, G, K) stars, of which class Fath's integrated spectrum (*Ap. Journ.*, Volume 36, page 362) indicates the galaxy mainly to consist.† According to all the recent studies embodied in Professor Russell's " absolute magnitude " diagram, these stars average at 0·8 " sun-power," and, taking these to be represented by the average galactic star of apparent magnitude 17, their mean parallax becomes ″·00045, giving a distance of two thousand two hundred and thirty secpars, or seven thousand two hundred and fifty light-years, which strikingly confirms the present estimate, and consequently the suggested Canopic hypothesis on which it rests.

There is, to conclude, one factor not to be ignored, and which, though at first sight irrelevant, yet, if established, should be decisive on the question of visible galactic distances, and that is the date of Creation. If the true interpretation of the period named in the inspired account (Genesis i) be six literal days—for which the Hebrew evidence seems strong—and if, again (though the evidence is not so definite), these days apply to the original creation named in the first verse (and not to any subsequent six-day " reconstruction," allowing an indefinitely long interval between this verse and the next), then it should follow that we cannot yet have received the light of stars lying beyond some six thousand light-years, or eighteen hundred secpars. One test, however, which will occur to those who have not committed themselves irretrievably to any one of the modern evolutionary doctrines (involving all ranges in millions of years) is whether, after an appreciable lapse of time, the number of stars down to a limiting magnitude (necessarily faint) tends to show any increase. The time required, however, is likely to be long, seeing that any appreciable increase in the number of suns able to impress themselves at such outlying distances necessitates a considerable proportionate extension in the star-depth, with its corresponding wait in light-years.

The possibilities of the Canopic hypothesis, as they now stand, may be summed up in the suggestion that :—

" The visible Universe, probably of oblate spher-
" oidal form, with an equatorial radius of some two
" thousand secpars, has its centre marked by the
" bright star Canopus, probably the greatest seen
" in the Universe, stationary therein, forty or
" more thousand times as luminous as our Sun, and
" nearly a million and a half times as massive.

" Meanwhile, our Sun, now distant a hundred and
" fifty secpars from Canopus, is travelling (from
" the influence, apparently, of some original impulse)
" at, for the present, just over thirteen miles a
" second in a course inclined rather more than
" twenty degrees (upwards) from the galactic plane,
" and rendered hyperbolic by the influence of
" Canopus, which would ultimately deflect it over
" thirteen degrees out of the straight. The attractive
" effect, meanwhile, of the other stars around may
" prove to be generally neutral."

As to what may lie beyond the galaxy, whether or not it be " the waters above the firmament," our boasted knowledge fails as yet to interpret aright the Creator's meaning therein expressed, while speculation becomes a useless search to be " wise above what is written." Meanwhile, as we work towards the true interpretation—whether we ever attain it or not—let us not forget to mark each step of our advance with that ascription of praise properly due to the One Who " telleth the number of the stars and calleth them all by name " ; Whose right hand, further, " hath spanned the heavens, and causes them to stand up together at His call." Thus may we, with increasing intelligence, join in the Heavenly ascription :—

> " Thou art worthy, O Lord, to receive glory and honour and power : for Thou hast created all things, and for Thy pleasure they are and were created."

* This pole seems to give the simplest representation of the truth, being the mean of Newcomb's reductions ; Newcomb's pole for the main stream alone lies in α192°·8m, δ+27°·2, the deviation of which, however, from that adopted here leaves the mean southward dip unaffected.

† This would seem to dispose of Professor See's exceptional estimate of a million light-years galactic distance, based on the assumption that the galactic stars are type B of nearly one thousand " sun-power."

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THE PHYSICAL CONDITIONS OF THE JEWISH RACE.

By ISRAEL COHEN, B.A.

(Continued from page 215.)

THE favourable conditions of health enjoyed by the Jews may be illustrated by examining the degree of their liability to various diseases. Contagious maladies, which work with such rapid and pernicious effects among most peoples, do not attack them at all so seriously, despite the apparent opportunities offered by a Ghetto environment.* In 1909 there was an outbreak of cholera in Vitebsk, in the Russian Pale, which (according to the census of 1897) contains 34,420 Jews and 31,299 non-Jews; but whilst 472 non-Jews were attacked, of whom 219 died, only 186 Jews were attacked, of whom 70 died. The mortality of the Jews was thus only 5, and that of their neighbours 15 per 1000.† The Jews are also more immune than their neighbours from typhoid fever. Thus, in Budapest, in 1886, their mortality from this disease was only 46 per 100,000, whilst that of the Catholics was 66, and of the Lutherans 76.‡ And in New York, during the six years ended May 31st, 1900, their mortality from typhoid was only 9·19 per 100,000, a lower rate than that of any other people. They suffer less from smallpox, as they practise vaccination regularly, and in the epidemic of 1900–3 in New York they were almost completely immune, as they were in the outbreak in Manchester in 1902.§ They are less liable to pneumonia, as their indoor occupations do not expose them to the rigours of the weather or the chilling of the body; and as they are not habitual drunkards they can offer a more effective resistance to the disease. On the other hand, owing to their being mostly townsfolk with indoor occupations, they are very liable to chronic bronchitis and asthma; and heart-disease claims a great number of victims, owing partly to their unusually severe struggle for existence and partly to their containing a large proportion of old persons, who are naturally liable to the malady. In the United States the Jewish mortality from heart-disease is double that of the general population. Rheumatism is also common, and so are varicose veins, especially among women, owing to their general indolence and their frequent pregnancy. A special form of the latter affection consists of haemorrhoids, which are more prevalent among Jews than among other people. This malady is particularly common among the Jews of Eastern Europe: its causation is due to a sedentary life, and is generally attributed to sitting nearly the whole day on the hard benches of the *Beth Hamidrash*, studying the Talmud. Cancer is believed to be less frequent among Jews than among non-Jews, though among the former it is more liable to attack the gastro-intestinal organs. On the other hand, cancer of the breast is less frequent among Jewish than among non-Jewish women.

Whether Jews show any particular immunity in regard to consumption is still a matter of dispute, though the bulk of the evidence would seem to be in their favour. Investigations made in Russia, New South Wales, and London show that the Jews are less liable than their neighbours to this disease. In 1897 the Jewish Board of Guardians of London appointed a committee to inquire into the alleged increasing prevalence of consumption among the Jewish poor with a view to adopting preventive measures, but the inquiry established the fact that there had not been any increase of this disease during the previous fifteen years. Dr. J. S. Billings has shown that the death-rate from consumption in New York and Brooklyn for the six years ended May 31st, 1900, was lowest among the Jewish population; a result confirmed by Dr. M. Fishberg, who has made investigations in the New York Ghetto, showing that the death-rate from this disease was 565·06 per 100,000 among non-Jews, but only 110·56 among Jews.‖ The pursuit of sedentary occupations, such as tailoring and boot-making, in the crowded dwellings of congested districts in big cities would lead one to expect a greater frequency of this malady among Jews; but there are counteracting factors in the careful inspection of their meat, the rarity of alcoholism, the regular cleaning of the house, and their general employment in trades that do not expose them to the inclemency of the weather. The eating of kosher meat and the moderate indulgence in intoxicants would seem to be the two chief causes

* In the Middle Ages the Black Death, which carried off so many thousands of people, left the Jews almost untouched, and hence they were accused of causing the death of others by poisoning the wells.

† *Zeitschrift für Demographie und Statistik der Juden*, 1912, page 63.

‡ J. von Körösi, in "Publikationen des statistischen Bureaus, Budapest" (Berlin, 1898).

§ "Minutes of Evidence," Royal Commission on Alien Immigration, pages 21, 794.

‖ "The Immigrant Jew in America," page 329.

for checking the ravages of consumption. On the other hand, diseases of the digestive organs, such as nervous dyspepsia and diabetes, are rather frequent causes of death, being due largely to excessive anxiety and a lack of proper exercise. Whether Jews are more often attacked by diabetes than their neighbours is another moot point, but Dr. Fishberg has shown that it is mostly a question of the location of the Jews, those in Germany falling easier victims to the malady than their co-religionists in Russia, France, or England.* The extent to which Jews are liable to diseases of the digestive organs is evidenced by the large numbers in which they flock every summer to such watering-places on the Continent as Carlsbad and Marienbad. Of eye-diseases, trachoma is rather frequent among the Jews of Eastern Europe, owing to their insanitary surroundings, but effective measures of prevention and healing have been adopted in recent years in consequence of this ailment being a ground for the exclusion of immigrants seeking to enter England or America. Of skin diseases eczema is said to be more common among Jews than among non-Jews, a phenomenon also due to an insanitary environment. Sexual diseases are notably less common, the comparative immunity being due partly to superiority in moral relations, partly to moderation in intoxicants, and partly to circumcision; but the favourable position of the Jew in this respect is slowly receding in Western countries in which there is increasing intercourse with the non-Jewish population.

The position of the Jewish child in regard to disease, as can be deduced from its comparatively low death-rate, is strikingly favourable, and is due to the greater devotion and care exercised by the mother both before and after birth. Jewish children succumb less frequently than others to diphtheria, croup, measles, and whooping-cough, but they more often die from scarlet fever. They show a better resistance to infantile diarrhoea, the mortality from which is only about one-third of that among non-Jewish infants. They are also less liable to rickets, atrophy, and scrofula. Striking evidence on this point was given before the Inter-Departmental Committee on Physical Deterioration, by Dr. W. Hall, of Leeds, who found fifty per cent. of the Christian children in a poor school suffering from rickets, but only eight per cent. of the children in a school of the better class, whereas in a Jewish school of poor children he found only seven per cent. attacked by this ailment.†

The liability of the Jews to nervous diseases is a subject of peculiar and pathetic interest. Distinguished by the superiority of their nervous over their muscular system, they are more prone to mental affections than other people in whom the nervous system is relatively less highly developed. According to various authorities, the frequency of mental diseases among Jews is from two to five times higher than among non-Jews. It is chiefly nervous diseases of a functional order, however, to which they are subject, particularly neurasthenia and hysteria, the latter being found among males to a notable degree. Raymond has actually asserted that the Jewish population of Warsaw forms an inexhaustible source of supply of hysterical males for the clinics of the whole Continent.‡ On the other hand, Jews are less liable to organic nervous diseases than non-Jews, thanks to the comparative infrequency among them of alcoholism and syphilis. Their peculiar position in respect to these disorders is due to a combination of historic and social factors. They have had to endure an endless cycle of persecutions ever since their exile from Palestine; they have been almost exclusively denizens of towns throughout that period, denied the stimulating influx of country blood; and they have largely been engaged in intellectual or commercial pursuits, and been exposed to the worry and anxiety incidental thereto. These factors, operating for so long a period, and over so wide an area, have rendered the Jewish nervous system peculiarly susceptible of attack, and they continue to exert undiminished sway to the present day throughout Eastern Europe. The persistent espionage and oppression, the chronic pogroms, and the daily fear of their recurrence, to which the Jews in Russia are exposed, have wrought disastrous effects among them—driving hundreds, nay, thousands, into an incurable state of insanity. According to the Russian census of 1897, the Jews had 9·84 mentally diseased in every 10,000, whilst the Russians had only 9·54, and the Poles 8·51.§ This unfavourable proportion has probably since become worse in consequence of the wholesale massacres of Jews in the autumn of 1905 and the sporadic outrages that broke out in the following year, the type of affection to which they are subject being more frequently melancholia rather than mania. In addition to these factors, one must also take into consideration the early age at which the Jewish child begins his education. His religious, if not his secular, education begins as early as the age of four or five, and throughout the greater part of Eastern Europe it is conducted mostly in an overcrowded and ill-ventilated room, which often forms the entire home of the teacher. An important point that must be borne in mind, however, in regard to the comparative frequency of insanity among Jews is that they are almost exclusively an urban population, whilst almost half of the non-Jewish world lives in the country. Thus a Jewish lunatic must invariably be brought into a public asylum, a necessity that operates to a less degree in the case

* "Jewish Encyclopaedia," Volume IV, article "Diabetes." † *Jewish Chronicle*, August 19th, 1904.

‡ "L'Étude des Maladies du Système nerveux en Russie" (Paris, 1889), page 71.

§ "Die sozialen Verhältnisse der Juden in Russland" (Berlin, 1906), page 68.

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of Gentile lunatics, and hence the disproportion between recorded Jewish and non-Jewish lunatics can to a certain extent be discounted. Despite the relatively high degree, however, in which Jews are attacked by nervous ailments, they are comparatively free from the severer or fatal forms of these diseases. Thus the mortality of the Russian Jew in New York from nervous maladies in the six years ended May 31st, 1890, was 117·68 per 100,000, whilst that of the Bohemians was 336·76, of the white Americans 293·48, and of the Irish 242·44.

Although insanity is the most potent predisposing cause of suicide, self-destruction is, on the whole, comparatively rare among Jews. The reason is to be sought in the controlling influence of religion, which is a recognised deterrent of self-murder, as well as in the traditional view of the Jew in looking upon life as something sacred. Throughout the crowded Jewish centres in Eastern Europe, where orthodoxy has its stronghold, suicide is a very infrequent phenomenon: only in periods of pogroms, when Jewish wives are dishonoured and Jewish girls are deflowered,* is there a notable manifestation of suicidal tendency. The cause is certainly sufficient. There is an appreciable difference, however, in the rate of suicide among different grades of Jewish society, its incidence being much more frequent among the rich than among the poor. Thus, in Austria, where the economic position of the Jews is low, the number of suicides is 20 per 100,000, and in Galicia, where the Jews are even worse off, it is 10 per 100,000, whilst in Baden and Bavaria, where they are on the whole in comfortable circumstances, the rate is 140.† The most significant feature in regard to self-murder among the Jews is its comparative increase in Western Europe and America, thus displaying one of the deleterious influences of modern civilisation upon Jewish life. In these Western lands, where the struggle of life is keener, and the bases of faith are weaker, the despair of the Jew finds a quicker outlet in self-destruction than in the Jewish centres of Eastern Europe, where there is not only a stronger faith in Providence, but where also the social stigma attaching to the family of a suicide acts as a potent deterrent. The increase in the rate of suicide in Western Jewry has become most striking during the last fifty years, the period that has witnessed the growth of emancipation and westward migration; and it is particularly noteworthy in Prussia, where the statistics of the ten years 1890–1901 show that, whilst the rate among the non-Jewish population of that country has remained almost stationary, it has increased among the Jews from 18 to 32 per 100,000.

Although modern Jewry has such a favourable record in regard to mortality and disease, it has a remarkably diminishing birth-rate, which is lower than the birth-rate of the general population in all the countries of Europe. Thus, in Prussia, Bavaria, and Hesse together, the average Jewish birth-rate sank from 31·6 per 1000 in 1876–80 to 17·6 in 1901–1910, and in Prussia alone, in 1911, it was as low as 15·4.‡ This contrasts very unfavourably, not only with the Christian birth-rate in Prussia, 29·7 per 1000, and with the general birth-rate for Germany, 28·7, but also with that of France in 1911, 18·9, which is commonly regarded as the lowest birth-rate in Europe. In Austria the Jewish birth-rate declined between 1899 and 1909 from 35·72 to 28·80 per 1000, and in Hungary between 1901–5 and 1906–10 from 31·4 to 28·6, falling again in 1911 to 26·9 (compared with 35·1 per 1000 of the general population).§ Even in countries farther east, where traditional piety still has its stronghold, the ancient ideal of being fruitful and multiplying is steadily waning. Thus, in Galicia, the Jewish births between 1899 and 1909 declined from 41·41 to 34·40 per 1000 (probably partly due to the large emigration); and in Roumania, between 1903 and 1910, they declined from 32·29 to 29·33, whilst the birth-rate of the general population increased from 40·14 to 50·11;‖ and in Bulgaria, between 1891–95 and 1907, they declined from 37·58 to 32·27, whilst the birth-rate of the general population rose from 37·49 to 43·85.¶ The same phenomenon has also manifested itself in Russia, where between 1900 and 1903 the Jewish birth-rate declined from 36·14 to 29·13, which contrasts strikingly with the birth-rate of the Greek Orthodox, 51·3 per 1000;** and in Poland likewise the Jews have the lowest birth-rate, 30, of any denomination, that of the Greek Orthodox being 43·26 per 1000.

This diminution of the birth-rate has altered the composition of the Jewish family, for whilst most families contained from four to six children even as recently as twenty years ago, they now have only from two to four, and there is an increasing tendency to restrict the number to two. The cause of this diminution is mainly to be found in the increase of celibacy and the postponement of marriage, with the consequent curtailment of the period of fertility, due to the increased standard of comfort and education; whilst a subsidiary cause consists in the prudential restraints and the sterilising effect of nervous irritability prevalent among educated classes. These causes operate, it is true, amongst nearly all town dwellers, Jewish or Gentile; but the Jews are almost exclusively a town people, whereas the Christians are to a large extent a rural folk, whose high birth-rate counterbalances the low birth-rate of the town population. To such a

* "The Immigrant Jew in America," page 299. † "Jewish Encyclopaedia," XI, article "Suicide."

‡ *Zeitschrift für Demographie und Statistik der Juden*, 1913, January and September.

§ *Ibid.*, 1912, pages 78 and 135; 1913, page 118. ‖ *Ibid.*, 1912, page 16.

¶ *Ibid.*, 1911, page 17. ** *Ibid.*, 1911, pages 39–44.

degree has celibacy now spread in modern Jewry that its marriage-rate has sunk below that of the Christian population almost throughout Europe. In Germany, in 1911, the marriage-rate of the general population was 7·80 per 1000, but that of the Jews was only 7·08; and in Hungary, in the same years, the figures were respectively 9·2 and 8·3 per 1000.* The same phenomenon has also manifested itself farther east. Thus, in Bulgaria, in 1907, the marriage-rate of the general population was 9·88 per 1000, but that of the Jews only 7·13;† and in Roumania, in 1910, the figures were respectivly 9·44 and 6·09 per 1000.‡ In Russia, too, the traditional idea of founding a family is on the wane: thus in 1903, whilst the marriage-rate of the Mahommedans was 11·4 per 1000, and that of the Greek Orthodox 9·2, that of the Jews was only 7·2, and in Poland it was as low as 6·1.§

The diminishing birth-rate of the Jews is partly counterbalanced by their low rate of mortality, but the advantage that they possess in this respect is limited in effect, and the net result is a lower rate of natural increase than that of the general population. Thus, in Germany, in 1905–10, the general population increased by 7·06 per cent. (the Protestants by 6·23 and the Catholics by 7·74 per cent.), whilst the Jews increased only by 1·17 per cent. In Holland, in 1899–1909, the general population increased by 14·77 per cent., but the Jews only by 1·12 per cent.‖ Similarly, in Austria (1901–10) the addition to the general population was 9·26 per 1000, whilst the Jewish increase was only 7·25, and in Galicia, in the same decade, the Greek and Roman Catholics increased by 8·67 and 11·64 per cent., whilst the Jewish increase was only 7·62 per cent.; in Roumania (1910) the figures were 14·82 and 12·13 respectively; and in Russia (1903) the addition to the Greek Orthodox population was 19 per 1000, whilst that of the Jewish population was only 14·8 per 1000. The effect of this diminishing rate of increase is that the Jews form a diminishing proportion of the general population in many European countries where there is no powerful stream of immigration. In Germany, in 1870, there were 125 Jews in every 10,000 of the population, but in 1910 there were only 95. This diminution was also partly due to apostasy and emigration, and it would even have assumed larger proportions but for the influx of Jews from Eastern Europe. Similarly, in Austria, in 1890, there were 478 Jews in every 10,000 of the population, but by 1910 the proportion fell to 459;¶ and in Italy, between 1861 and 1901, the proportion fell from 13·31 to 10·96 per 10,000 of the total population.** The declining rate of increase of the Jews is in itself an ominous sign for the future; whilst the diminishing proportion which they form of the general population in so many countries is a further disquieting factor, as it exposes them in a steadily increasing measure to the forces of assimilation.

* *Zeitschrift für Demographie und Statistik der Juden*, 1913, page 119. † *Ibid.*, 1911, page 17.
‡ *Ibid.*, 1912, page 16. § *Ibid.*, 1911, pages 39-44.
‖ *Ibid.*, 1911, page 166. ¶ *Ibid.*, October, 1912. ** *Ibid.*, 1905, January.

CORRESPONDENCE.

HIGH TIDE AT FREMANTLE.

To the Editors of "KNOWLEDGE."

SIRS,—Your correspondent, Mr. W. Gornold, and his would-be helpers are hopelessly at sea, which is only to be expected perhaps on a question concerning tides.

None of them seems to be aware of the fact that "Fremantle," Australia, is spelt with only two "e's."

They all speak of a single tide per day as the normal state of things, and agree that Southampton has two. This is wrong. The normal number is two per day, but here at Southampton we have four.

The exceptional state of things at this port is one of the chief causes of her prosperity. It goes on all the year round, and is not limited to the syzygies, as stated by Mr. Gornold. Neither is it confined to Southampton. Havre, St. Malo, Portland, and Selsea Bill all share in this curious phenomenon, while outside these limits it gradually becomes less marked as one proceeds up or down Channel, until it is at length lost at Dover and Land's End.

The cause of these remarkable double tides is most interesting and instructive. The main tidal wave which is born in the Atlantic, and prevented from following the Moon by the deflecting land masses of the American Continent, finds its way across to the British Isles, where it splits into three branches. One of these loses itself in the Irish Sea. Another enters the English Channel, and gives us our first high water. The third branch is the cause of the abnormality. It passes right round by the west and north of Ireland and Scotland, enters the North Sea, and meets the second branch at Dover just twelve hours late. It is thus in time for the next ordinary high water there, and no abnormality is apparent, therefore, until it enters the Channel, and begins to make its way to the westward, when its ever-increasing lateness becomes manifest, and a double tide is seen. This west-going branch then gives us our second high water two hours (apparently) after the normal tide. It is really fourteen hours late, however, and as it proceeds down Channel past Portland and Weymouth the gap between the first and second floods gets wider and wider until ultimately the effect is that of a double low water, known locally as the "gulder."

It is absurd to drag in an "astronomical factor" to explain a purely local irregularity, which must of necessity be terrestrial in origin. Any such factor, *e.g.*, Syzygy and R.A. (M——), cannot be limited to a particular spot on the Earth's surface, but must affect the whole ocean at once. The only reference to astronomy needed is the time of the Moon's Meridian Passage (upper or lower). The interval between that and the time of high water is given on charts and in tide-tables, and is called the "Establishment of the Port," or, as the sailor says, "High Water Full and Change."

Any departure from the regularity of this Establishment is to be explained by local causes, and these are legion. I have gone pretty fully into one only. Others can be found in the Admiralty Tide-tables (1/6).

A. E. LARKMAN.

LARKMAN'S ACADEMY,
SOUTHAMPTON.

XUM

THE TWILIGHT ARC.

By MAXWELL HALL, M.A., F.R.A.S.

(Kempshot Observatory, Jamaica.)

In an article on the "Colours and their Changes at Sunset on a Tropical Island" in "KNOWLEDGE," Volume XXXVI, page 54, reference was made to some difficulty in discriminating between the last of the Twilight Arc in the evening, or its commencement in the morning, and the base of the Zodiacal Light; and, indeed, if the axis of the latter is much inclined to the horizon, it seems impossible to do so; but when the axis of the light is nearly perpendicular to the horizon, and when the sky is clear down to the very horizon, observations can be made which lead to their discrimination.

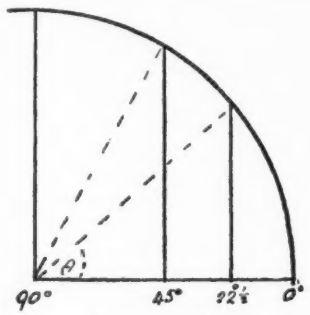

FIGURE 290.

Now the breadth of the Zodiacal Light and the length of the Twilight Arc along the horizon depend on the clearness of the air; but when the Sun is 21° below the horizon we may take the breadth of the base of the light to be about 32°, and consequently we never see either the last or the commencement of the Twilight Arc, for they are lost in the glow of the former.

We are therefore obliged to measure the angular length of the arc along the horizon, and to deduce from the length the altitude of the highest point of the arc above the horizon; and this altitude converted into hour-angle will give the reduction of the observation to the time when the highest point of the arc was on the horizon, or 90° from the zenith.

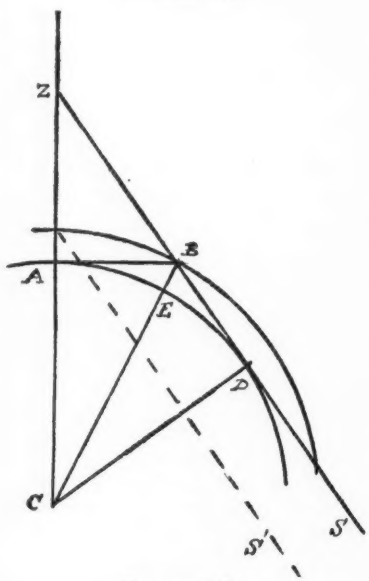

FIGURE 291.

These moments of time lead to the computation of the greatest height in the atmosphere where the air has the power of reflecting the light of the Sun; they also give us the greatest observed breadths of the Zodiacal Light, which form an important part of a long series of observations I have made on the light itself.

My earlier observations this year on the length of the arc were made on the supposition that there would be no difficulty in connecting its length with its altitude; but it was found that the absorbing power of the atmosphere near the horizon was so great that for a given altitude the observed length was much smaller than the computed length, and that an unknown quantity was thus introduced into the problem.

My later observations include different measures taken during the same morning or evening, so as to establish a formula connecting altitude and length based entirely on observation.

Let α be the altitude of the summit of the arc above the sensible horizon, so that α will be measured along the axis of the Zodiacal Light; and let β be the distance from the axis along the horizon to an end of the Twilight Arc; then if α and β be both expressed in degrees, and if θ be an auxiliary angle, it will be found that the observations give

$$\left.\begin{aligned}\alpha &= 7^\circ \sin\theta \\ \beta &= 90^\circ \operatorname{vers}\theta\end{aligned}\right\} \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

When β is given, θ is known, and then α; and the time-reduction to the zero of α and β is merely 4α in minutes, omitting small refinements depending on the latitude and the Sun's declination.

The geometrical figure (see Figure 290) corresponding to (1) is also remarkably simple. In this quadrant β is measured in degrees from 0 to 90 along the axis of x; the ordinates at right angles to x multiplied by 0·31 give the corresponding values of α.

And to show that Figure 290 suits our observations we have to compare the differences between the different values of α corresponding to the different values of β. We thus have the following table:—

β	α	Reduction to Zero. min. sec.
15°	3° 52′	15 28
22½	4 38	18 32
45	6 4	24 16
90	7 0	28 0

This table has been tested; for instance, on

October 24th for $\beta = 15°$ the observed altitude of the arc as near as possible to the edge of the Zodiacal Light was about 4°; and for $\beta = 45°$ it was similarly about $6\frac{1}{2}°$.

And from this table and the table of observations below we obtain the following :—

β	Intervals of Time. Observed. min.	Computed. min.
From 15° to 22½°	4	3
„ 15 „ 45	9	9
„ 15 „ 90	12	12½
„ 22½ „ 45	5	6
„ 22½ „ 90	9	9½
„ 45 „ 90	5	4

The differences between the observed and computed times are well within the probable errors of observation; and the equations (1) are therefore as right as we can make them.

In Table 37 the mean local time given in the second column corresponds to β in the third; and then the beginning or end of twilight was found by applying the reduction as explained above. And finally the zenith distance of the centre of the Sun was easily computed.

Analysing these values of z, the Sun's zenith distance, we have :—

β	No. of Observations.	z.
15°	7	111° 21′
17	1	111 17
20	1	112 47
22½	4	111 24
30	4	111 4
45	8	111 41
48	1	111 31
90	4	111 18

where there is apparently no systematic error. Similarly the eight evening observations give 111° 26′, and the twenty-two morning observations give 111° 27′; so again there is apparently no systematic error. The mean of the whole series of thirty observations is 111° 27′, with a probable error of 6′.

In order to compute the greatest height in the atmosphere where the air has the power of reflecting the light of the Sun, in Figure 291, where refraction has been neglected, let SDBZ be the ray of light which, passing through the atmosphere and touching the Earth's surface at D, is reflected at the greatest height B to the observer at A. Then as $\angle ZAS' = z$, we have $\angle BAS' = z - 90°$; $\angle ABD = 270° - z$; and $\angle ABC = 135° - \frac{z}{2}$.

And if a be the Earth's radius AC, or EC, and h the height of the reflecting atmosphere, BE, we

TABLE 37.

Civil Day. 1912.	Mean Local Time.	β.	Beginning or End of Twilight. Mean Time.	Beginning or End of Twilight. App. Time.	Sun's Decl.	Sun's Zenith Distance.
	hr. min.		hr. min.	hr. min.		
Jan. 4	6 51 p.m.	22½°	7 10 p.m.	7 5 p.m.	−22° 47′	111° 32′
„ 8	6 56 „	15	„ 11 „	„ 4 „	−22 19	„ 13
Feb. 12	7 7 „	30	„ 28 „	„ 14 „	−13 53	„ 36
April 6	„ 21 „	„	„ 42 „	„ 40 „	+ 6 37	„ 14
„ 7	„ 20 „	„	„ 41 „	„ 39 „	+ 7 0	110 51
„ „	„ 29 „	22½	„ 48 „	„ 46 „	„ „	112 26
„ 12	„ 29 „	15	„ 44 „	„ 43 „	+ 8 50	111 1
„ 13	„ 27 „	22½	„ 46 „	„ 46 „	+ 9 12	„ 33
June 22	4 10 a.m.	30	3 49 a.m.	3 47 a.m.	+23 27	110 35
„ „	„ 16 „	90	„ 48 „	„ 46 „	„ „	„ 47
Aug. 24	„ 35 „	45	4 11 „	4 9 „	+11 11	111 51
Sept. 10	„ 42 „	„	„ 18 „	„ 21 „	+ 5 2	„ 36
„ 11	„ 44 „	„	„ 20 „	„ 23 „	+ 4 39	„ 16
„ 21	„ 36 „	15	„ 21 „	„ 28 „	+ 0 43	„ 31
„ „	„ 39 „	17	„ 22 „	„ 29 „	„ „	„ 17
„ „	„ 46 „	48	„ 21 „	„ 28 „	„ „	„ 31
„ 23	„ 37 „	15	„ 22 „	„ 30 „	0 0	„ 18
„ „	„ 46 „	45	„ 22 „	„ 30 „	„ „	„ 17
Oct. 18	„ 35 „	15	„ 20 „	„ 35 „	− 9 33	113 3
„ „	„ 46 „	45	„ 22 „	„ 37 „	„ „	112 35
„ 19	„ 43 „	15	„ 28 „	„ 43 „	− 9 55	111 16
„ „	„ 51 „	45	„ 27 „	„ 42 „	„ „	„ 30
„ „	„ 55 „	90	„ 27 „	„ 42 „	„ „	„ 30
„ 20	„ 40 „	20	„ 22 „	„ 37 „	−10 17	112 47
„ „	„ 46 „	45	„ 22 „	„ 37 „	„ „	„ 47
„ „	„ 51 „	90	„ 23 „	„ 38 „	„ „	„ 33
„ 24	„ 49 „	15	„ 34 „	„ 50 „	−11 42	110 6
„ „	„ 53 „	22½	„ 34 „	„ 50 „	„ „	„ 5
„ „	„ 56 „	45	„ 32 „	„ 48 „	„ „	„ 34
„ „	5 1 a.m.	90	4 33 a.m.	4 49 a.m.	−11 42	110 20

have $a + h = a \operatorname{cosec} (135° - \frac{z}{2})$. But refraction has considerable effect, and it may be easily shown that if r be the horizontal refraction this equation becomes

$$a + h = a \operatorname{cosec} \left\{ 135° - \tfrac{1}{2}(z - 3r) \right\} \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

whence h may be found.

Taking $z = 111° 27'$, $r = 31'$; and $a = 3961$ miles, we have $h = 60$ miles, and the distance AB very nearly 700 miles.

The depression of the Sun below the horizon at the commencement or end of twilight, namely, 21° 27', and the corresponding height of sixty miles, observed and computed, are much greater than the values usually assigned to them.

We have now to consider the circumstances affecting the base of the Zodiacal Light. From Figure 290 it appears that the form of the Twilight Arc is that of the upper half of a constantly changing elongated ellipse whose semi-axes are β and a respectively, and the form of the Zodiacal Light is that of a tapering cone stretching across the whole sky, but very dim between 120° and 170° from the Sun, when it then slightly increases to 180°. In Figure 294 the arc has been taken to be 32° broad at its base where it meets the arc 21° from the Sun, tapering to 15° about 90° from its base upwards; and Figure 294 gives the appearance of the Zodiacal Light when there is very little diffused light near the horizon and when it is seen at its best.

But when there is much diffused light in the sky, which increases towards the horizon and forms there a white band of considerable breadth, the phenomena are now represented by Figure 295; the shape of the light has been changed, and its base unduly lengthened to about 51° at the same distance of 21° from the Sun.

My earlier measures made some thirty-five years ago gave a figure similar to Figure 295; later observations made some six years ago, when I had much other work to do, even increased the width of the base; the latter observations and their results were published in the *United States Monthly Weather Review* for March 1906. The present series now on hand with leisure at my disposal indicates that when the atmosphere is at its best the light takes the form of Figure 294 instead of that of Figure 295, and allows us to discriminate between it and the Twilight Arc.

But, putting measures aside, the light is a beautiful feature in our tropical morning and evening skies, and deserves far more general attention than it has yet received.

VARIABLE STAR CHARTS.

THE American Association of Variable Star Observers offers to all those interested in the observation of variable stars a valuable set of charts, in blue print, of long-period variable stars at a remarkably low price.

These charts, two hundred and forty in number, are a combination of the Harvard College Observatory photographic charts, the Durchmusterung chart enlargements, and charts from Father Hagen's Atlas. In every case comparison stars are designated with light-values reduced to a common standard, that adopted by the Harvard College Observatory.

These charts may be purchased singly at five cents each, or the whole set for ten dollars post paid. The sets are printed on large sheets, ten to sixteen charts to the sheet. The H.C.O. charts are $7\frac{1}{2} \times 10\frac{1}{2}$, the Hagen charts $8\frac{1}{2}$ inches square.

One of the drawbacks to variable-star observing heretofore has been the high cost of the valuable and indispensable Atlas Stellarum Variabilium of Father Hagen. No claim is made that the charts advertised are the equal of the Hagen charts, but they are an inexpensive, serviceable, and valuable set of charts that should be in the hands of all observers of long-period variable stars not provided with adequate or sufficient material. The charts are furnished gratis to all members of the Association, and are offered to other observers through the courtesy of Professor E. C. Pickering, Director of the Harvard College Observatory.

It may be added that the said Association extends a cordial invitation to all observers to join its ranks. Those interested are requested to address the undersigned,

WILLIAM TYLER OLCOTT.

Norwich, Conn., U.S.A.

JUPITER'S RED SPOT IN 1913.

The great red spot of Jupiter in June, 1913, was within the south tropical disturbance, and observations made during its passage through that region are of peculiar interest. The mean daily motion of the south tropical disturbance was a little more than 0°·3 during the previous year, and as the motion of the red spot was much less the south tropical disturbance overtook it. Figure 292 shows the preceding white loop of the disturbance and the white oval which marks the position of the red spot. The observation was made with an eleven-inch reflector, magnifying the planet about 360 times; and, as the seeing was good, considerable detail was detected. A small white spot following the red spot bay seems to be a characteristic marking of this region, as it was observed in the same position a number of times during the 1912 apparition of Jupiter. Faint wisps were seen in the red spot, but the spot as a whole seems to be somewhat brighter than last year. According to my observations, the longitude of the centre of the red spot bay was 305° on June 2nd, 1912, and 300° on October 1st, 1912. On April 1st, 1913, it was about 277°, and on May 25th it was 268°. Allowing for a large probable error, because of low altitude and generally bad seeing in April, the motion of the red spot seemed to have greatly increased, as though it was being carried along with the more rapidly moving disturbance in the southern tropics. As can be seen by the drawing, the disturbance, which started in the northern equatorial belt in August, 1912, continued in the form of a number of dark spots, almost evenly placed, extending nearly around the planet.

Nashville, Tenn., U.S.A. LATIMER J. WILSON.

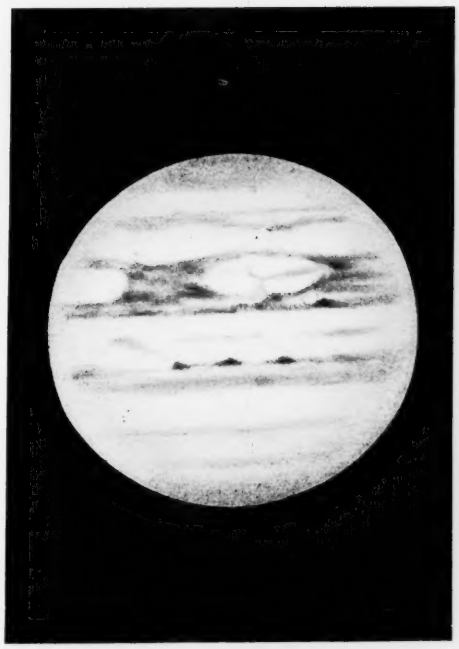

FIGURE 292.

Jupiter, showing the position of the red spot (white oval), May 24th, 1913, 20h 42m G.M.T.
(See page 298.)

FIGURE 293.

Photo-micrograph of a piece of American Red-Gum Wood. × 15 diameters.
(See page 313.)

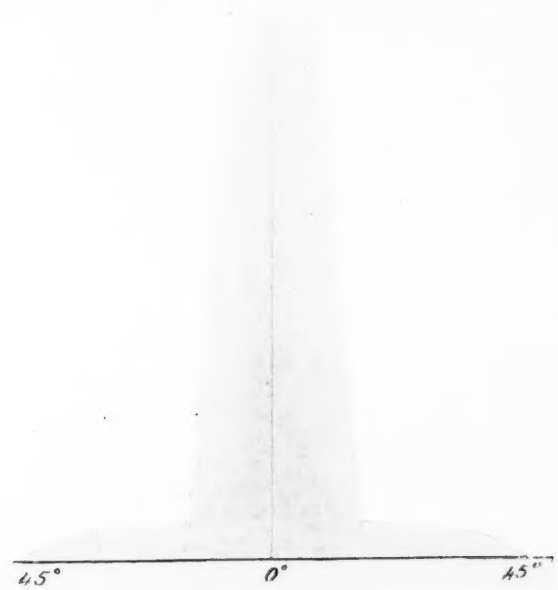

FIGURE 294.

When there is little diffused light near the horizon.

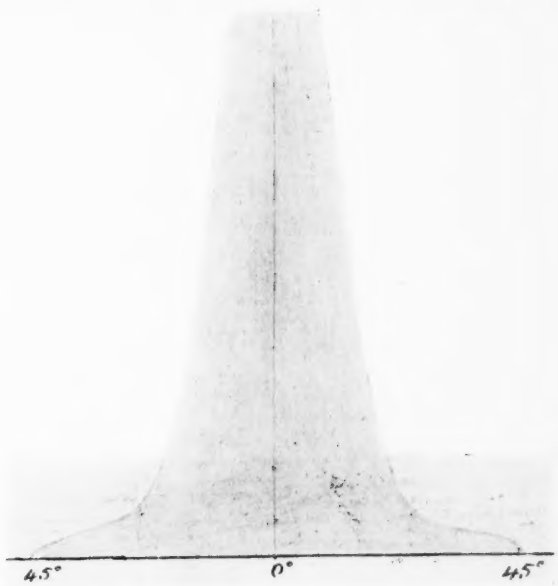

FIGURE 295.

When there is much diffused light which increases towards the horizon.

The appearance of the Zodiacal Light. (See page 296.)

FIGURE 296. The May Lily in Flower.

FIGURE 297. A Bed of the May Lily.

From photographs by Stanley Crook.

THE MAY LILY *(MAIANTHEMUM CONVALLARIA).*

By A. R. HORWOOD, F.L.S.

(With Illustrations from Photographs by Stanley Crook.)

THERE is always a charm about a rare flower. It is always likely to have been overlooked in some spot hitherto unknown to anyone; and, if perchance it should be our good fortune to discover a new locality for one of such rarities, it is indeed a red-letter day in our botanical annals.

Such a flower is the May Lily. Very few people, not strictly botanists, as well as perhaps some of the latter, have indeed even heard of it.

The May Lily is perhaps most plentiful at Hackness, about six miles from Scarborough, where it grows in much the same way as the Lily-of-the-Valley in woods. It was formerly to be found in Northumberland, at Howick. Other localities for it now or in the past are: Caen Wood, Middlesex; Dingley Wood, Preston; Harwood, Blackburn, according to Gerard; and Hunstanworth, Durham. It has more recently been discovered in North Lincolnshire.

The natural order to which it belongs is the Asparagaceae, to which also belong the Lily-of-the-Valley, Asparagus, Solomon's Seal, and Butcher's Broom, all but Asparagus, which grows on cliffs, being woodland plants.

It has the Lily-of-the-Valley habit, which is characteristic, several stems being put forth from a slender, creeping rhizome, which enables the plant to spread and to form a patch or bed. Were it not for this characteristic, probably it would ere now have become extinct in some of the few localities where it is found. This feature indeed has saved many an attractive plant liable to be rooted up by the hawker or thoughtless collector. The stems, being annual, die down in winter.

The stem is erect and leafy, with alternate leaves, rather flexuose, and downy or glabrous. The leaves are deeply cordate, triangular, with parallel nerves and short strands at right angles, or campylodromous. The leaves are borne upon short stalks, or petioles.

The flowers are arranged in a raceme, and are small and white, sulphur yellow in bud, the raceme about an inch in length, and unbranched, the short slender pedicels being clustered. They are solitary, or from two to three in number. The parts of the flower are in fours, the perianth-segments being free, and in one series, or there may be six segments in two series; the segments are spreading or reflexed. There are also four or six stamens basifixed on the petals. The flower is suberect and fragrant. There is a single short bifid style, the stigma is blunt, with two or three obscure lobes. The ovules are two in each cell of the two- or three-celled ovary. The fruit is a white or red two-celled berry, which is dotted and small.

The May Lily is the only species of the genus found in Europe, though others occur in America.

While generally growing in woods it is also found in pastures. There is a little doubt as to its being a native except at Scarborough. The illustrations accompanying this article (see Figures 296 and 297) are from specimens growing at Scarborough. They show well the associated habit of the plant. The May Lily varies in height from six to eight inches. It is in flower in May and June.

CORRESPONDENCE.

RUSSIAN PEASANTS' ARITHMETIC.

To the Editors of "KNOWLEDGE."

SIRS,—In reply to the query of the Rev. G. T. Johnston on the Russian method of multiplication I would suggest the following simple proof:

Take a number, say 15. Now $15=2\times7+1$; also $7=2\times3+1$, and $3=2\times1+1$;

$$\therefore 15=2\times7+1=2(2\times3+1)+1=2(2[2\times1+1]+1)+1$$
$$=2^3+2^2+2+1.$$

Any number may be decomposed in a similar manner. Thus, by dividing 25 by 2, it is easily seen that it can be represented in the following way:

$$25=2^4+2^3+0\times2^2+0\times2+1,$$

where the coefficients of 2^2 and 2 are 0.

Now suppose we want to multiply 25 by 11. Arrange the numbers as follows:

$$25=1+0\times2+0\times2^2+2^3+2^4;$$
$$\therefore 11\times25=11+0\times22+0\times44+88+176$$
$$=11+88+176=275.$$

It is easily seen from this why a line is drawn right across when the left-hand number, in Mr. Johnston's example, is even. We repeat the example given by Mr. Johnston, so that the method will be more apparent.

$$\begin{array}{r} 25\times11 \\ \cancel{12\times22} \\ \cancel{6\times44} \\ 3\times88 \\ 1\times176 \end{array}$$

Adding up the figures remaining on the right we obtain 275.

The other example given, 19×17, can be treated in the same way. Thus

$$19=2\times9+1=2(2\times4+1)+1=2(2[2\times2+0]+1)+1$$
$$=2\left(2\left[2\left\{2\times1+0\right\}+0\right]+1\right)+1$$
$$=2^4+0\times2^3+0\times2^2+2+1.$$

Hence $19\times17=17+34+272=323$.

(REV.) M. DAVIDSON.

CANNING TOWN, E.

THE FACE OF THE SKY FOR SEPTEMBER.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 38.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Uranus. R.A.	Uranus. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m	°
Sept. 5	10 53·9	N. 7·0	23 29·7	S. 1·6	11 15·7	N. 6·3	13 41·1	S.12·5	21 8·2	S.17·5	6 3·9	N.22·3	20 44·0	S.18·8	8 6·4	N.19·9
,, 10	11 11·9	5·2	3 13·0	N.23·2	11 48·0	N. 2·4	14 0·3	14·8	21 6·3	17·7	6 5·3	22·3	20 43·4	18·9	8 7·0	19·9
,, 15	11 29·8	3·3	7 46·6	N.24·8	12 18·2	S. 1·5	14 19·3	16·9	21 4·6	17·8	6 6·6	22·3	20 42·9	18·9	8 7·6	19·8
,, 20	11 47·8	N. 1·3	12 14·5	S. 4·4	12 46·8	5·2	14 38·1	18·9	21 3·2	17·9	6 7·6	22·3	20 42·4	18·9	8 8·1	19·8
,, 25	12 5·8	S. 0·6	17 8·2	S. 28·0	13 14·2	8·7	14 56·5	20·7	21 2·1	18·0	6 8·5	22·3	20 42·0	18·9	8 8·5	19·8
,, 30	12 23·8	S. 2·6	21 48·7	S. 14·3	13 40·4	S. 11·9	15 14·5	S. 22·3	21 1·4	S.18·0	6 9·2	N.22·3	20 41·7	S.19·0	8 8·9	N.19·8

TABLE 39.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	°	h. m.	h. m.
Sept. 5	+ 22·1	+7·2	207·1	−21·8	−18·9	+0·2	313·3	111·1	1 17 *e*	8 56 *m*
,, 10	23·2	7·2	141·0	−15·1	18·8	0·2	23·1	142·7	1 32 *m*	6 0 *e*
,, 15	24·2	7·2	75·0	+ 9·2	18·7	0·2	92·8	174·2	7 19 *e*	7 12 *m*
,, 20	25·0	7·1	9·0	+22·1	18·6	0·2	162·3	205·7	7 34 *m*	4 16 *e*
,, 25	25·6	6·9	303·0	+ 5·4	18·5	0·1	231·8	237·0	3 31 *e*	3 24 *e*
,, 30	+ 26·0	+6·7	237·0	−18·0	−18·4	+0·1	301·2	268·3	3 46 *m*	4 37 *m*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone, System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1, T_2 multiples of $9^h\ 50^m{\cdot}5$, $9^h\ 55^m{\cdot}7$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving southward with maximum speed, it crosses Equator (Autumn Equinox) $23^d\ 9^h\ 35^m e$. Its semi-diameter increases from 15′ 53″ to 16′ 0″. Sunrise changes from $5^h\ 13^m$ to $5^h\ 59^m$; sunset from $6^h\ 47^m$ to $5^h\ 41^m$.

MERCURY is an evening star. Semi-diameter 2½″. Illumination nearly full.

VENUS is an evening star, ½ of disc illuminated. Semi-diameter 12″. The fact of its declination being south of the Sun impairs the conditions of observation for northern observers. At East Elongation, 46½° from Sun, on 18th.

THE MOON.—Full $4^d\ 2^h\ 1^m e$. Last quarter $12^d\ 5^h\ 48^m e$. New $19^d\ 9^h\ 33^m e$. First quarter $26^d\ 0^h\ 3^m e$. Apogee $9^d\ 4^h m$. Perigee $21^d\ 6^h m$, semi-diameter 14′ 46″, 16′ 37″ respectively. Maximum librations 11^d 7° S., 15^d 7° E., 23^d 7° N., 27^d 7° W. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 40).

PARTIAL ECLIPSE OF THE MOON.—September $4^d\ 0^h\ 17^m e$ to $3^h\ 33^m e$. Magnitude of eclipse 0·863. It is invisible in Europe, visible in the Pacific, Australia, New Zealand, Eastern Asia.

MARS is practically invisible.

JUPITER is in Capricornus, 26′ South of θ Capricorni on 30th. Polar semi-diameter, 21½″.

Configuration of satellites at $9^h\ 30^m e$ for an inverting telescope.

JUPITER'S SATELLITES.

Day.	West.		East.		Day.	West.		East.	
Sept. 1	41	○	3	2●	Sept. 16	4	⊙	12	
,, 2	43	○	12		,, 17	4312	○		
,, 3	421	○			,, 18	432	○	1	
,, 4	324	○	1		,, 19	431	○	2	
,, 5	3	○	42	1●	,, 20	4	⊙	32	
,, 6	1	○	234		,, 21	24	○	13	
,, 7	2	○	134		,, 22	12	○	43	
,, 8	1	○	34	2●	,, 23		○	3124	
,, 9	3	○	124		,, 24	31	⊙	4	
,, 10	3 1	○	4		,, 25	32	○	14	
,, 11	32	○	14		,, 26	31	○	24	
,, 12	3	○	24	1●	,, 27	3	○	124	
,, 13	41	○	23		,, 28	2	○	34	1●
,, 14	42	○	13		,, 29	21	○	43	
,, 15	412	○	3		,, 30	4	○	312	

The following satellite phenomena are visible at Greenwich, $1^d\ 10^h\ 5^m\ 56^s e$, II. Ec. R.; $2^d\ 6^h\ 45^m\ 57^s e$,

III. Sh. E.; $4^d\ 0^h\ 57^m\ 15^s\ m$, I. Oc. D.; $10^h\ 4^m\ 22^s\ e$, I. Tr. I.; $10^h\ 41^m\ 4^s\ e$, I. Sh. I.; $5^d\ 0^h\ 21^m\ 51^s\ m$, I. Tr. E.; $0^h\ 58^m\ 41^s\ m$, I. Sh. E.; $7^h\ 23^m\ 40^s\ e$, I. Oc. D.; $10^h\ 20^m\ 9^s\ e$, I. Ec. R.; $6^d\ 6^h\ 48^m\ 17^s\ e$, I. Tr. E.; $7^h\ 27^m\ 26^s\ e$, I. Sh. E.; $7^d\ 2^h\ 19^m\ 12^s\ m$, II. Tr. I.; $8^d\ 8^h\ 24^m\ 16^s\ e$, II. Oc. D.; $9^d\ 0^h\ 42^m\ 46^s\ m$, II. Ec- R.; $7^h\ 8^m\ 34^s\ e$, III. Sh. I.; $7^h\ 52^m\ 13^s\ e$, III. Tr. E.; $10^h\ 47^m\ 29^s\ e$, III. Sh. E.; $10^d\ 7^h\ 50^m\ 31^s\ e$, II. Sh. E.; $11^d\ 11^h\ 50^m\ 30^s\ e$, I. Tr. I.; $12^d\ 0^h\ 36^m\ 9^s\ m$, I. Sh. I.; $2^h\ 7^m\ 54^s\ m$, I. Tr. E., $9^h\ 9^m\ 52^s\ e$, I. Oc. D.; $13^d\ 0^h\ 15^m\ 13^s\ m$, I. Ec. R.; $7^h\ 4^m\ 56^s\ e$, I. Sh. I.; $7^h\ 37^m\ 7^s\ e$, IV. Tr. E.; $8^h\ 34^m\ 34^s\ e$. I. Tr. E.; $9^h\ 22^m\ 25^s\ e$, I. Sh. E.; $10^h\ 24^m\ 58^s\ e$, IV. Sh. I.; $14^d\ 6^h\ 44^m\ 1^s\ e$, I. Ec. R.; $15^d\ 10^h\ 43^m\ 12^s\ e$, II. Oc. D.; $16^d\ 7^h\ 40^m\ 14^s\ e$, III. Tr. I.; $11^h\ 10^m\ 2^s\ e$, III. Sh. I.; $11^h\ 18^m\ 51^s\ e$, III. Tr. E.; $17^d\ 7^h\ 34^m\ 27^s\ e$, II. Sh. I.; $8^h\ 31^m\ 40^s\ e$, II. Tr. E.; $10^h\ 26^m\ 48^s\ e$, II. Sh. E.; $19^d\ 1^h\ 37^m\ 39^s\ m$, I. Tr. I.; $10^h\ 57^m\ 6^s\ e$, I. Oc. D.; $20^d\ 8^h\ 4^m\ 36^s\ e$, I. Tr. I.; $9^h\ 0^m\ 12^s\ e$, I. Sh. I.; $10^h\ 21^m\ 56^s\ e$, I. Tr. E.; $11^h\ 17^m\ 37^s\ e$, I. Sh. E.; $21^d\ 8^h\ 39^m\ 11^s\ e$, I. Ec. R.; $9^h\ 44^m\ 20^s\ e$, IV. Oc. D.; $23^d\ 1^h\ 4^m\ 58^s\ m$, II. Oc. D.; $11^h\ 11^m\ 30^s\ e$, III. Tr. I.; $24^d\ 8^h\ 11^m\ 17^s\ e$, II. Tr. I.; $10^h\ 11^m\ 16^s\ e$, II. Sh. I.; $11^h\ 3^m\ 25^s\ e$, II. Tr. E.; $25^d\ 1^h\ 3^m\ 2^s\ m$, II. Sh. E.; $26^d\ 7^h\ 16^m\ 0^s\ e$, II. Ec. R.; $27^d\ 0^h\ 45^m\ 26^s\ m$, I. Oc. D.; $9^h\ 0^m\ 37^s\ e$, III. Ec. R.; $9^h\ 53^m\ 12^s\ e$, I. Tr. I.; $10^h\ 55^m\ 33^s\ e$, I. Sh. I.; $28^d\ 0^h\ 10^m\ 28^s\ m$, I. Tr. E.; $7^h\ 12^m\ 41^s\ e$, I. Oc. D.; $10^h\ 34^m\ 20^s\ e$, I. Ec. R.; $29^d\ 6^h\ 37^m\ 47^s\ e$, I. Tr. E, $7^h\ 41^m\ 45^s\ e$, I. Sh. E.; $30^d\ 9^h\ 31^m\ 3^s\ e$, IV. Sh. E.

Eclipses will take place to the right of the disc in an inverting telescope, taking the direction of the belts as horizontal.

SATURN is a morning star, in Gemini. Polar semi-diameter $8\frac{1}{2}''$. Major axis of ring $42''$, minor $18\frac{1}{2}''$. Angle $P-6°\cdot2$.

Eastern elongations of Tethys (every 4th given) $1^d\ 5^h\cdot9\ m$, $8^d\ 7^h\cdot2\ e$, $16^d\ 8^h\cdot4\ m$, $23^d\ 9^h\cdot7\ e$; Oct. $1^d\ 10^h\cdot9\ m$; of Dione (every 3rd given) $3^d\ 8^h\cdot3\ m$, $11^d\ 1^h\cdot5\ e$, $19^d\ 6^h\cdot6\ e$, $27^d\ 11\cdot7e$; of Rhea (every 2nd given) $7^d\ 7^h\cdot7e$, $16^d\ 8^h\cdot7e$, $25^d\ 9^h\cdot7e$.

For Titan and Japetus E., W. stand for East and West elongations, I for Inferior (North) conjunction, S. for Superior (South) conjunction. Titan $2^d\ 5^h\cdot9\ m$ I, $6^d\ 3^h\cdot2\ m$ W., $10^d\ 3^h\cdot5\ m$ S., $14^d\ 6^h\cdot3\ m$ E., $18^d\ 5^h\cdot8\ m$ I., $22^d\ 2^h\cdot7\ m$ W., $26^d\ 3^h\cdot1\ m$ S, $30^d\ 5^h\cdot7\ m$ E.; Japetus $5^d\ 1^h\cdot4\ e$ I., $24^d\ 9^h\cdot4\ e$ W.

URANUS is an evening star in Capricornus, 2° North of Moon on 1st.

NEPTUNE is a morning star, still too near the Sun for convenient observation.

COMETS.—See "Notes on Astronomy."

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
	°	°	
June-Sept. ...	335	+ 57	Swift.
July 25-Sept. 15	48	+ 43	Swift, streaks.
July-Sept. ...	335	+ 73	Swift, short.
July-October...	355	+ 72	Swift, short.
Aug.-Sept. ...	353	− 11	Rather slow.
Aug.-Sept. ...	346	0	Slow.
Aug.-Oct. 2...	74	+ 42	Swift, streaks,
Aug.-Sept. ...	63	+ 22	Swift, streaks.
Sept. 5-15 ...	62	+ 35	Swift, streaks.
Sept. 6-17 ...	106	+ 52	Swift, streaks.
Sept. 15-24 ...	14	+ 6	Slow.
Sept. 21 ...	31	+ 19	Slow, trains.
Sept. 27-30 ...	4	+ 28	Slow.
Sept. 28-Oct. 9	320	+ 40	Slow, small.

In the cases where the radiant is stated to be active for several months, there is a difference of opinion as to whether it can be regarded as a single shower or a combination of several.

DOUBLE STARS AND CLUSTERS.—The tables of these given two years ago are again available, and readers are referred to the corresponding month of two years ago.

VARIABLE STARS.—The list will be restricted to two hours of Right Ascension each month. The stars given in recent months continue to be observable (see Table 41).

TABLE 40. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Time.	Disappearance. Angle from N. to E.	Reäppearance. Time.	Reäppearance. Angle from N. to E.
1914.			h. m.	°	h. m.	°
Sept. 1 ...	17 Capricorni	5·8	8 34 *e*	54	9 52 *e*	253
,, 4 ...	Wash. 1507	6·8	3 45 *m*	74	—	—
,, 9 ...	BD + 16°·247	6·4	0 13 *m*	57	1 29 *m*	237
,, 10 ...	Wash. 176	6·7	—	—	2 50 *m*	233
,, 10 ...	16 Tauri	5·4	11 10 *e*	115	11 53 *e*	200
,, 10 ...	19 Tauri	4·3	11 19 *e*	79	0 23 *m* *	235
,, 10 ...	21 Tauri	5·8	11 41 *e*	74	0 48 *m* *	240
,, 10 ...	20 Tauri	4·1	11 42 *e*	119	0 23 *m* *	195
,, 10 ...	22 Tauri	6·5	11 44 *e*	83	0 50 *m* *	231
,, 11 ...	BD + 24°·562	7·0	—	—	1 12 *m*	209
,, 12 ...	BD + 26°·731	7·0	—	—	0 44 *m*	289
,, 13 ...	BAC 1746	6·5	0 49 *m*	112	1 45 *m*	229
,, 13 ...	BD + 27°·1122	7·0	—	—	11 59 *e*	198
,, 14 ...	BD + 27°·1164	6·9	—	—	3 44 *m*	277
, 17 ...	BAC 3209	6·3	3 19 *m*	80	4 10 *m*	318
,, 26 ...	Wash. 1220	6·8	7 58 *e*	77	—	—
,, 30 ...	BAC 7709...	7·0	6 39 *e*	110	—	—

From New to Full disappearances take place at the Dark Limb, from Full to New reäppearances.

* The asterisk indicates the day following that given in the date column.

Attention is drawn to the occulation of the Pleiades on September 10–11.

XUM

TABLE 41. NON-ALGOL STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m.	°		d.	
UW Pegasi	22 14	+2 ·3	8·5 to 9·7	185	Aug. 13.
δ Cephei	22 26	+58 ·0	3·6 to 4·3		
V Cassiopeiae..	23 8	+59 ·2	7·1 to 12·6	229	Aug. 8.
TY Andromedae	23 11	+40 ·3	8·2 to 10·0	144	Aug. 3.
W Pegasi	23 15	+25 ·8	7·3 to 13·0	342·6	July 22.
SV Cassiopeiae	23 35	+51 ·8	7·5 to 9·2	272	Sept. 2.
Z Aquarii	23 48	−16 ·3	7·3 to 9 5	216	Sept. 29.
R Cassiopeiae...	23 54	+50 ·9	4·8 to 13·2	431·6	Sept. 21.
W Ceti	23 58	−15 ·2	6·5 to 12·5	355	Aug. 20.

Minima of Algol $2^d\ 3^h \cdot 8\ m$, $5^d\ 0^h \cdot 6\ m$, $7^d\ 9^h \cdot 4\ e$, $10^d\ 6^h \cdot 2\ e$, $25^d\ 2^h \cdot 3\ m$, $27^d\ 11^h \cdot 1\ e$, $30^d\ 7^h \cdot 9\ e$. Period $2^d\ 20^h\ 48^m \cdot 9$.

Principal Minima of β Lyrae September $1^d\ 9^h\ e$, $14^d\ 7^h\ e$, $27^d\ 5^h\ e$. Period $12^d\ 21^h\ 47^m \cdot 5$.

CORRESPONDENCE.

SOME FRUITLESS EFFORTS TO SYNTHESISE LIFE.

To the Editors of "KNOWLEDGE."

SIRS,—The recent discussion on spontaneous generation, based largely upon Dr. Charlton Bastian's experiments, makes it difficult for me to hold my peace when it is borne in mind that I was in part, and to a very large extent, responsible for the revival of the subject in recent years.

Readers interested in the subject will find in *Nature*, May 28th, an interesting communication from Mr. B. A. Keen on the subject of cellular structures in emulsions. These formations, like Dr. Bastian's, are undoubtedly physical effects; but the peculiar striae, or layers, in a test-tube, in the nature of horizontal rings at regular distances down the tube, are of special interest and significance to the physicist, quite apart from the bearing which they may or may not have upon the question of cell structure in living matter.

A description of these, and the literature relating to them, has been given in my book on "The Origin of Life," with many cautions and precautions for the unwary. The continuity of nature can be maintained only by a reëditing of the biological dictionary, as Professor J. Arthur Thomson has pointed out.

Now I have been taken to task for publishing my results in the popular press; but this I venture to ask the hospitality of your coloumns to explain again, and in part to contradict. My results were published in the first instance in *Nature*. It was after that that I was interviewed by the *Daily Chronicle* and other papers, an honour not often accorded to a man of science. So invidious, indeed, did the course I had decided to take appear that certain dons of unspeakable nervousness were said to have got into hysterics like militant suffragettes, and their tarantic behaviour equalled only that of corybantic Christians of the Salvationist School; nor have they since ceased to hurl their boomerangs of unseemly epithets against me on every conceivable occasion.

The phenomena I have described are, I think, clearly physical effects, and not merely chemical, as has been suggested.

Let me emphasise, moreover, that I have done my best not to ignore or minimise the importance of the work of other observers working on similar lines, and that full credit is given in my book, and references given to their experiments and publications; for instance, those of M. Raphael Dubois. I do not know, however, how far his observations tally with my own, both in the details which I have given and in their relation to the ring formations, as also to the action of light.

It may be of particular interest just now to note that the aggregates formed by the action of radio-active salts on certain organic media disintegrate under the influence of light, just as Madame Victor Henri has found in the case of various bacilli.

These effects would most probably be produced also by the presence of radio-active bodies of a certain strength, instead of ultra-violet light, in both cases by the β and γ rays, and cause the subdivision of the nucleus when the radio-active substance is within it, without any external influence.

The formation of these rings, which are of the nature of layers approximately equidistant, in a test-tube containing the emulsion or colloid substance, is just what might be expected if the cells contained some slight radio-activity. This activity will subdivide the cells into innumerable particles, until a certain thickness of the medium in which they are immersed sufficed to cut off the radiation, when they would again begin to be formed under the influence through which they originally came together, until the process of disintegration once more exceeded that of aggregation, and the rings again broke up. A series of strata of cells would result recurrently down the test-tube, as I have described.

It seems necessary to emphasise once more in this perennial controversy that I have never claimed that these experiments afford direct first-hand evidence of spontaneous generation at the present day. They give rather, in my opinion, some suggestive analogies as to the manner in which cellular structures were first formed in protoplasmic substances without affording any explanation of the chemical synthesis of the latter.

It is the nuclear substance "germ plasm" that, still more than ordinary protoplasm, lies beyond our grasp; and it is the origin of the latter, and not that of protoplasmic cells, that constitutes the great enigma of life.

Throughout the whole range of the physical and biological sciences which it has been my endeavour to master for years past, I can find no trace of evidence or clue as to its nature and probable origin.

The phenomena of heredity and continuity of germ plasm indicate, no doubt, that these properties are ultra-atomic, and all that can be said at present is that the study of life leads us, not to molecules, atoms, and electrons, as many suppose, but that, through heredity, the phenomena of germ plasm inevitably carry us beyond them.

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NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

THE TOTAL NUMBER AND TOTAL LIGHT OF THE STARS.—I have more than once alluded in this column to the photographic map of the entire sky that was made by the late Mr. Franklin Adams. One of the objects that he had in view was to give more reliable figures than were previously available for the number of stars of each of the fainter magnitudes. When his health failed he handed over the plates to the Royal Observatory for the completion of this task. It was beyond the resources available to attempt to count all the stars on each plate, so a selection was made of certain small squares, symmetrically arranged over its area. The stars in these squares were counted, and the number on the whole plate estimated from the result. This work was undertaken by Messrs. Chapman and Melotte, and they have published their results in "Memoirs of the R.A.S.," Volume LX, Part IV.

One of the first requisites was to have a definite scale of magnitudes. The Harvard photographic sequence of stars near the North Pole was taken as the standard, its substantial accuracy being confirmed in many ways. In order to have standard stars, on the same scale of magnitude, distributed over the sky, numerous photographs were taken with the thirty-inch reflector at Greenwich. Duplicate exposures were made on each plate of the pole and of another region of the sky. Each exposure lasted about thirty-five minutes, which sufficed to show stars of the seventeenth magnitude. It was difficult to get sufficiently clear nights and to keep the focus of the mirror the same when the telescope was moved. Not more than thirty satisfactory plates were obtained in a year, but these sufficed for the purpose. Further plates are being taken at Helwan, Egypt, to carry the standard stars into the southern hemisphere.

One difficulty was the change in the character of the star images on the Franklin Adams plates, according to their distance from the centre: this appears to be fairly regular, and a table for the purpose was constructed.

The plates so far discussed do not completely cover even the northern hemisphere, but they are sufficiently well distributed, both in galactic longitude and latitude, to form reliable estimates of star-density. The stars are grouped in zones ten degrees wide according to their galactic latitude, north and south latitudes being combined. The zone at the galactic pole extends twenty degrees in latitude. I quote here the number of stars per square degree of and brighter than each separate magnitude, (A) in the galactic zone, and (B) in the galactic polar zone:—

Magnitude	5.	6.	7.	8.	9.	10.	11.
A ...	·027	·102	·359	1·16	3·51	9·77	25·4
B ...	·013	·048	·158	·468	1·30	3·31	7·94
	12.	13.	14.	15.	16.	17.	
A ...	61·7	141	306	631	1245	2399	
B ...	18·0	38·5	77·6	155	295	556	

It will be seen that for the brighter stars A is twice B; for the fainter ones A is four times B. The numbers for the whole sky down to various limiting magnitudes are (in units of a million): To magnitude ten, a quarter; to magnitude eleven, two-thirds; to magnitude twelve, one and two-thirds; to magnitude thirteen, three and two-thirds; to magnitude fourteen, seven and a half; to magnitude fifteen, fifteen and a half; to magnitude sixteen, twenty-nine and a half; to magnitude seventeen, fifty-five; while the guesses by extrapolation for magnitudes eighteen and nineteen are ninety-one and one hundred and forty-four. The numbers are much smaller than those obtained by previous workers; thus the Bonn Durchmusterung contained one-third of a million stars down to nominal magnitude nine and a half in the northern hemisphere alone. It is probable that many of the stars labelled nine and a half would be given as ten, or fainter, or the modern photometric scale. There also seems to be a tendency for the photographic magnitudes of the faint stars to be fainter than the visual ones. The authors note that their figures clearly point to a diminution in the ratio of new stars that are added when the limiting magnitude is extended by one unit. On the assumption that there is no absorption of light in space this points to the limit of our star system being approached. They think that the number of stars in it would lie between one thousand one hundred and one thousand eight hundred millions, of which about half would be brighter than the twenty-fourth magnitude.

COMETS.—Delavan's interesting comet, which was discovered last December, but which will not pass perihelion till October 26th, has been hidden in the Sun's rays since April. It has now emerged, and is visible in the morning sky. It was first seen by Mr. W. H. Steavenson on July 4th at Mr. Worthington's observatory, Alton. It could be seen at an altitude of 1°, so that it was probably at least as bright as the sixth magnitude. He says: "It seemed fairly circular, condensed towards its centre, where there was a nucleus of about magnitude 7½. The diameter of the part seen was 5′; had the sky been darker faint outlying portions would doubtless have been seen." I think that the prospects are hopeful for this comet being an interesting spectacle in September and October. There is already no doubt that it will be visible to the naked eye. It will be in Lynx and Ursa Major in August and September, and will be best observed shortly before daybreak.

An ephemeris for August was given last month: it is continued here:—

		R.A.			N.Dec.	
		h	m	s	°	′
Sept.	8 ...	9	8	35 ...	49	56
,,	16 ...	10	8	6 ...	49	51
,,	24 ...	11	9	33 ...	47	56
Oct.	2 ...	12	7	1 ...	44	9
,,	10 ...	12	56	44 ...	38	56
,,	18 ...	13	37	56 ...	32	57
,,	26 ...	14	11	50 ...	26	45
Nov.	3 ...	14	40	44 ...	20	40

Another very faint comet was found by M. Neujmin at Simeis, Crimea at the end of June: it passed perihelion at midnight on February 11th, omega being 289° 2′, node 265° 45′, i 36° 19′, perihelion distance 1·3545. It is rapidly fading, and will not be visible in small instruments.

THE SOLAR ECLIPSE OF AUGUST 21st.—Mr. A. Burnet, of Leeds, has kindly sent me some calculations he has made about the partial eclipse in England. Using corrected elements for the Moon from recent Greenwich observations, he finds for the beginning, greatest phase, and end of the eclipse at Greenwich the times 10h 58m 55s *m*, 0h 10m 49s *e*, 1h 20m 48s *e*. The beginning will be 63s earlier for each degree of latitude north of Greenwich, and 62s earlier for each degree of longitude west. The greatest phase will be 60s earlier for each degree of latitude north, and 80s earlier for each degree of longitude west. The end will be 58s earlier for each degree of latitude north, and 90s earlier for each degree of longitude west. The magnitude is ·021 greater for each degree of latitude north and ·011 less for each degree of longitude west. From these figures any observers within, say, one hundred miles of London will be able to predict the phenomena fairly accurately. Any observers who have the means of getting time to a second, by wireless telegraphy or otherwise, can do useful work by timing the first and last contacts. I recommend projecting the Sun's image through the telescope on to a screen in a darkened room, if this can be arranged. The approximate position of first contact must be known (see

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the Face of the Sky for last month). Observers with spectroscopes can observe the first contact with greater accuracy by seeing the Moon projected on the chromosphere before it reaches the limb. True first contact is given by the instant when the dark Moon breaks the continuity of the lower chromosphere. It cannot be actually seen visually on the Sun till a second or two later than the geometrical contact. The method will also be available for the first contact in the transit of Mercury on November 7th.

The experience of Professor Newall in 1912 shows that it is possible to do useful work on the reversing layer in large partial eclipses. The points to be examined are those near the cusps.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

PLANKTON (FLAGELLATES AND GREEN ALGAE) OF THE ADRIATIC.—For some years systematic observations on the biology of the Adriatic Sea and neighbouring parts of the Mediterranean have been carried on by Austrian workers in the exploring ship "Najade." Schiller (*Sitzb. kais. Akad. Wiss. Wien*, Band 122) has published two papers on the most minute of the plankton forms, the so-called nannoplankton consisting of vegetable forms too small to be captured by means of nets, but obtainable from the water by the use of centrifugal apparatus and filters. It is becoming increasingly evident that the vegetable portion of the plankton—the small organisms which float freely suspended, especially in the upper waters—is of immense importance in the economy of the sea, and therefore to mankind. These plankton plants—Diatoms, Peridineae, Flagellata, and other minute organisms of more or less definitely vegetable nature (that is, capable of manufacturing organic food from inorganic materials by virtue of their chlorophyll or other light-absorbing pigment which enables them to fix carbon dioxide)—are either eaten directly by fishes or even by huge marine animals like whales, or form the food of smaller marine animals which in turn are eaten by fishes. Schiller's first paper deals with the Coccolithophoridae—the organisms of which portions of the limy covering were long ago known and described as "coccoliths"—of which he describes more than twenty new species. The whole of the Adriatic was explored for these minute organisms, samples being taken at ten-mile intervals, and in each case at thirteen different depths ranging from 0·9 metre to 1000 metres. The seasonal distribution of the minute Coccolithophoridae, which were obtained by the centrifuge method, was found to correspond in essential with that of the larger plankton forms (net-plankton), showing a minimum in winter (mid-November to mid-February); then a steady increase reaching a maximum in August and September, followed at the end of September by a rapid diminution. During the two years of the cruise this group was found to be represented in every part of the Adriatic, frequently in great abundance—as many as one million per litre of water. Various interesting points in the biology of this relatively little-known group of Flagellata were made out; for instance, the fact that six of the species can live in relatively fresh water containing less than 1·5 per cent. total salts. The inshore or littoral forms are more than twice as abundant as the pelagic or open-sea forms. As regards their vertical distribution the Coccolithophoridae are, like the Diatoms, essentially surface organisms, reaching their maximum either close to the surface at two to five or between two and twenty metres depth. This distribution is mainly conditioned by light intensity, since, despite the great fall in temperature observed in August, from about 23° C. in the surface water (0–10 metres) to about 16° C. at twenty metres many of the species occur abundantly in the lower depths; in August as many as four hundred and sixty individuals per litre were found at two hundred metres, as compared with sixteen thousand at the surface and over nineteen thousand at twenty metres. Below about twenty-five metres there is a rapid falling off in numbers; the result obtained by Lohmann off Syracuse—maximum at about fifty metres—is regarded by the author as an exceptional case attributable to purely local conditions, since the "Najade" observers found the greatest abundance of Coccolithophoridae in the Strait of Otranto in the upper twenty metres. The Adriatic results agree, however, in most respects, save the greater abundance, with those obtained by Lohmann for the Atlantic, the differences being attributed to the better methods and instruments used by the Austrian workers. Lohmann found that at Syracuse the maximum occurred in May the water containing about three thousand individuals per litre. The Austrian workers obtained in the not far distant Adriatic stations about fourteen thousand per litre in May and over nineteen thousand in August, the latter figure far exceeding that (seven thousand) given by Lohmann for the Atlantic. The waters of the Adriatic are therefore much richer in Coccolithophoridae than those of any other sea that has been investigated.

Finally the author emphasises the great importance of this group—which as he states is undoubtedly of vegetable nature, having yellow-brown or yellow-green chromatophores, with oil as assimilation product—as producers of organic substance. They occur in the alimentary canal of all plankton-devouring animals. The Salpas (free-swimming Tunicates) which in spring feed chiefly on Diatoms, rely largely upon the Coccolithophoridae and Peridineae after the Diatom maximum has passed, while Pteropods like the Cymbuliidae contain large quantities of these organisms throughout the year. From these observations it would appear that the Coccolithophoridae may play a much larger part in the nutrition of marine animals than has hitherto been attributed to them, the important point so far as the Adriatic is concerned being the fact that this group attains its maximum in summer at a time when there is a striking diminution in amount of the larger (net) phytoplankton forms.

(*To be continued.*)

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

SULPHUROUS AND SULPHURIC ACIDS AND VEGETATION.—An experimental investigation has been made by Messrs. Tatlock and Thomson (*Analyst*, 1914, XXXIX, 203) to ascertain the effect of sulphurous and sulphuric acids in the atmosphere upon the health of plants. The localities from which the plants were taken ranged from places where the air was exceptionally pure to districts where there was an atmosphere contaminated with gases and smoke. It was found that sulphurous acid became speedily oxidised to sulphuric acid in the plant, and the results were therefore calculated in terms of the latter (SO_3). The plants grown in a polluted atmosphere frequently showed three times or more the quantity of sulphuric acid found in the same plants grown in a fairly pure atmosphere. Thus grass usually contained a maximum of 0·3 per cent. of SO_3, but grown in a polluted atmosphere showed as much as 1·0 per cent. In spite of this difference, the grass was perfectly healthy, provided that free acid was not present.

This conclusion was borne out by many other results. For example, oak leaves from Langside (Glasgow) contained up to 0·42 per cent. of SO_3, but did not show any acidity, whereas oak leaves from another district contained only 0·202 per cent. of SO_3, but were acid and damaged.

Again, healthy neutral birch leaves from Langside contained 0·86 per cent. of SO_3, whereas acid and damaged leaves from a locally polluted spot contained only 0·248 per cent.

Observations made upon the air in the different districts

showed that it was only under exceptional circumstances that the atmosphere was acid, even in the case of cities burning large quantities of coal, the sulphuric acid derived from the coal being neutralised by ammonia from the same source, or by the bases in the floating dust in the air. When the air was found to be acid, as, for example, in the vicinity of acid fumes from chemical works, or from the burning of coal containing an excessive amount of sulphur (up to five or six per cent.), damage to vegetation was noted; but the effects were strictly local, and after the fumes had been dispersed into the surrounding air no acidity could be detected in the atmosphere, and plant life was apparently unaffected.

THE WATER OF DORTON.—In the village of Dorton, near Brill, in Buckinghamshire, there is a remarkable mineral spring which about the year 1830 was exploited as a spa, but has long since been abandoned. This spring had been known to the natives for many generations, and owing to its inky taste was commonly described as the "Alum Well." The ground for a radius of many feet was stained a deep yellowish-brown, from the deposition of iron oxide and sulphate, and from the astringent properties of the water the well had acquired a local reputation as a bath for mangy dogs and for "tanning" them for bull-baiting.

At the time when this spring was developed into a spa an analysis of the water was published by Professor Brande, and it is interesting to compare the results with the composition of the water at the present day. An analysis made last year by the present writer is published in the current issue of the *Analyst*, 1914, XXXIX, 210, and for convenience the figures obtained by Brande in 1830 are calculated upon the same basis of parts per one hundred thousand.

	Mitchell. 1913.		Brande. 1830.
Iron } Aluminium } ...	45·6	.....	32·0 3·52
Calcium	40·0	.....	31·20
Magnesium	15·0	.....	—
Sodium	8·5	.....	6·29
Sulphuric Acid (SO_4)	243·0	.....	202·89
Chlorine	10·0	.....	9·71
	362·1	.....	285·71

It will be seen that while the amounts of sodium, calcium, and chlorine have remained fairly constant, there has been a remarkable increase in the amount of iron sulphate. The water has a slight acid reäction, probably owing to the presence of free sulphuric acid, and this was also noted by Brande.

ENGINEERING AND METALLURGICAL.

By T. STENHOUSE, B.Sc., A.R.S.M., F.I.C.

THE PRODUCTION OF STEEL DIRECT FROM ORE.—In a paper read before the Iron and Steel Institute Messrs. Ernest Humbert and Axel Hethey give details of the smelting of Swedish and Brazilian iron ores to various grades of steel in an arc (Héroult) electric furnace. Melting was found to proceed quite normally, and reduction of the ore to follow normal chemical laws. There was much ebullition, owing to the large volume of oxides of carbon set free from the liquid bath. This is an essential difference from the reäction in modern blast furnaces, where spongy iron is first produced and then melted. The outstanding quality of the steels produced was their toughness, and this, the authors conclude from the nature of the process, is to be ascribed to the substantial absence of both nitrogen and hydrogen. Nitrogen, which is usually considered to have about five times the effect of phosphorus in producing brittleness and decrease of elongation, is added to steel by means of the air-blast in the case of blast-furnaces, converters, and cupolas, and in the case of open-hearth furnaces is probably added in the form of cyanogen and ammonium compounds by means of the flame. It is supposed to be present in the ferrite constituent of the steel as a nitride; it does not combine with the iron carbides. The effect of hydrogen in steel is also little understood, but the action is probably similar to that of nitrogen. The authors have come to the conclusion that with the aid of the modern electric furnace, and given satisfactory conditions, the economic manufacture of steel direct from ore is a practical possibility, and that the material produced will be superior to that manufactured by present methods.

A CURIOUS CASE OF DECARBURISATION DURING THE HARDENING OF STEEL DIES.—In some preliminary trials of an electric muffle for hardening steel dies the steel (containing about one per cent. of carbon and one per cent. of chromium) was allowed to soak at 820° C. for about one and a half hours, the working face of the die being protected against scaling by a sheet-iron cover filled with powdered charcoal. On removal from the furnace the cover was knocked off, the face brushed free from charcoal, and the block quenched under a spray. Curiously enough, the working face, which had been in contact with charcoal during the heating, was found to be soft to a depth of about half a millimetre, below which the steel was glass hard. Repeat tests showed that the effect of the charcoal covering was always to reduce the carbon content of the face to about 0·4 per cent. in one and a half hours. Some unprotected strips of similar steel heated alongside for comparison showed no loss of carbon at the face. Dr. H. C. Greenwood has communicated these observations to the Iron and Steel Institute with the object of ascertaining if similar effects have been observed by others.

GEOGRAPHY.

By A. STEVENS, M.A., B.Sc.

AN EXAMPLE OF RIVER-CAPTURE.—One of the most striking examples of the phenomenon of river-capture which these islands presents is seen in the headwaters of the rivers Spean and Spey in the south of Inverness-shire (see Figure 298). The feature is equally striking, whether examined by map or in the field. The general slope of the highlands of Scotland, as is well known, runs from north-west to south-east, and the consequent or primary river system follows that direction. The grain of the country is perpendicular to this line. A well-developed subsequent river system has grown up in that direction, and, on the whole, provides the dominant drainage system. Loch Laggan lies in a through subsequent valley whose floor is entirely below the thousand-foot contour. The river Spean provides an outlet to the loch. From the south-west end of the loch it flows in a course a little south of west to join the river Lochy, which empties into Loch Linnhe. The main stream feeding Loch Laggan is the river Pattack, which rises in the high land south of Beinn a Chlachair, and flows towards the north-north-west to within two miles of Loch Laggan. Its course then bends sharply to the south-west, and the river flows into the north-west end of the loch. Running parallel to the upper part of the Pattack, and about two miles to the east of it, is the Mashie Water, which rises in the hills west of Loch Ericht. When it reaches the through valley of Loch Laggan, this river turns north-east to join the Spey. Between the points where the Mashie and the Pattack bend the divide is remarkably low, and there can be little doubt that at one time the Spean flowed across it to form a tributary of the Spey. On the way it received as tributaries what are now the upper parts of the Pattack and the Mashie. An obsequent stream cutting back from the shores of Loch Linnhe must have captured the headwaters of the Spean, and brought about in time the reversal which now obtains. The tributaries of the Spean below Loch Laggan give strong support to this view. The map shows several of them coming in from the west, and

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they approached in that direction so close to the main river that, judging by the map, one would say they flow in against its current. The river Roy shows similar features. It also has been brought to its present condition by the capture and reversal of streams at the head of the Spey.

While the Spean-Spey system is perhaps the most noticeable example of the phenomenon in the district, it is by no means the only striking one. The Truim-Ericht system may be mentioned, but maps of the adjoining parts may be studied with interest for numerous others.

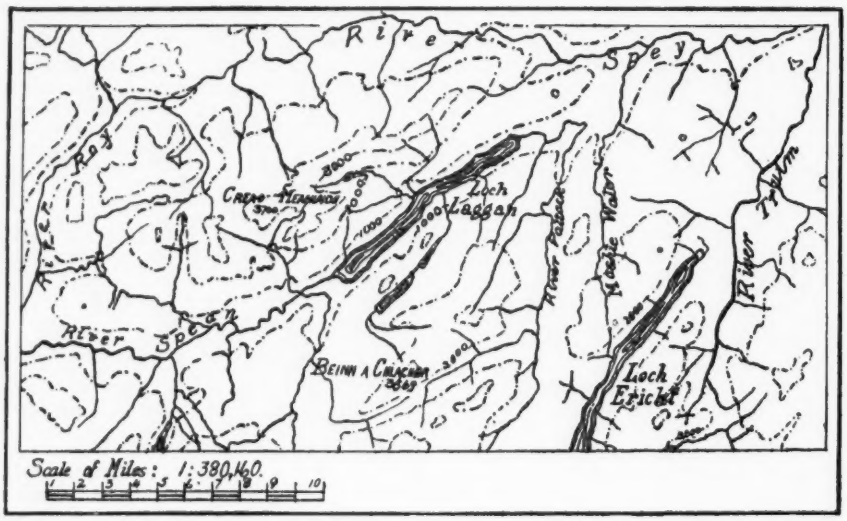

FIGURE 298. Sketch Map of Headwaters of Rivers Spean and Spey, with approximate contours at 1000 feet vertical interval.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

BALLSTONE.—An elaborate study of the peculiar lenticular structure known as ballstone, occurring in the Wenlock Linestone of Shropshire, has been made by Miss M. C. Crosfield and Miss M. S. Johnston (*Proceedings of the Geologists' Association*, XXV, 1914). The ballstones are unstratified, ovoid, or lenticular masses of limestone embedded in hard courses of stratified limestones. The bedding-planes of the latter generally stop abruptly where they abut against ballstone, but near the top of the lenticle they may curve over without discontinuity. The size of the ballstones varies greatly, but some reach a height of sixty to eighty feet. Both the ballstone and the adjacent stratified limestone contain a rich coral and stromatoporoid fauna; but in the former the fossils are mainly in the position of growth, and are enveloped by a flour-like calcareous matrix, whereas in the stratified limestones the fossils are largely in the condition of broken fragments.

The ballstones are considered to be the relics of large coral and stromatoporoid colonies still in the position of growth. They are identical in form and structure with the unstratified limestone masses which have been termed "reefs" by many authors. "The absence of coarse brecciated rock suggests that the colonies lived in comparatively calm or sheltered waters, whilst the fine, flour-like matrix in which the colonies are embedded is indicative of destructive wave-action at no very great distance, which has supplied the material, intercepted by the branching corals, and caught in the interspaces between the colonies. Such conditions are analogous to those now found behind a barrier reef or in a lagoon. That the colonies were originally of greater extent, but subsequently suffered destruction, is deduced from the presence of the large and identical coral fauna found scattered and overturned in the adjacent stratified beds." An instructive comparison is made with similar structures in the Palaeozoic limestones of Yorkshire, Belgium, and Gotland, the Tertiary bryozoan limestones of the Sea of Azov and the Black Sea, and in the Clinton and Niagara limestones of the United States.

The placoidal shape of the ballstones is ascribed to processes of contraction of the calcareous rock-flour during or shortly subsequent to the consolidation of the coral-rock and the death of the corals.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

THE THUNDERSTORM IN SOUTH LONDON, JUNE 14TH.—Thunderstorms are supposed to occur during the summer months, so those which took place in many parts of the country during June were what might be ordinarily expected. The thunderstorm which passed over South London on Sunday, June 14th, was of a severe character, although not exceptional; but as several persons were killed by lightning while sheltering under trees on Wandsworth Common, more attention than usual was given to this storm. My observations at Dulwich may be taken as representative of what occurred in most of the area affected. Thunder was first heard a little before 12.30 p.m., and lightning was seen from about 12.45. These continued more or less throughout the afternoon until 5.0 o'clock, the lightning being very brilliant and rather frequent. Heavy rain fell from 12.50 until 1.10, and from 1.15 to about 2.20. Some white hail fell about 1.45 p.m., but at 2.0 there was a very heavy fall of big hailstones, as large as marbles, which lasted about five minutes. Many of these hailstones were like large acid tablets, about an inch long, half an inch broad, and more than a quarter of an inch thick. The hailstones were composed of perfectly clear ice, and did not contain any white opaque structure. Hailstones are usually accompanied by gusts or squalls of wind: in this storm, however, there was but little wind. When these big hailstones fell they tore the leaves off the trees, and so the pavements became quite green with the fallen leaves. The heavy rain quickly washed many of these away, so that they were carried into the gutters, and soon stopped up the drains, with the result that the roads were flooded. A minute or so after the big hailstones had fallen a mist arose above the road and pavement to a height of about four feet; this, however, gradually disappeared. Rain came on again about 3.15 p.m., and continued till 4.0. The total rainfall amounted to 2·15 inches, of which I believe about 1·60 to 1·75 inches must have fallen in three-quarters of an hour, from 1.30 to 2.15 p.m. Apparently there were four or five different thunderstorms.

COTTON AND WEATHER.—At the meeting of the Royal Meteorological Society on June 17th Mr. B. C. Wallis read a paper on "The Rainfall of the Southern Pennines." This enquiry had been undertaken with a view of attempting to find a scientific justification of the claim made for the wetness and humidity of Lancashire suitable to the manufacture of cotton. In summarising the distribution of the rainfall of the Pennine district, the author said it may be asserted that the west is wetter than the east on the whole

and as a rule, although the difference between the two areas is least marked during the dry season from March to May. In June and July, however, the lowland of the Trent and Ouse valleys received a relative excess of rainfall, which is compensated by the relative dryness in December and January. The uplands are absolutely wetter than the neighbouring lowlands, and the western slopes are wetter than the eastern slopes, but the difference in rainfall between upland and lowland is least marked during the warm weather and most marked during the cold weather. Throughout the whole district, on the average, the rainfall decreases in intensity from January until April, increases from April to August, shows a drop in relative quantity for September, rises to a maximum in October, and then declines until December. The south-westerly and westerly winds bring a steady rainfall, which is almost the sole rainfall during the winter months. The dry season occurs when the air temperatures are decreasing—when the British Isles are, as it were, in a tepid, not a hot bath. The months of maximum rainfall are months when the air temperature is decreasing, and when the variant winds from north, east, and south, in turn or together, bring more rain than during other seasons, so that the surplus rainfall of these months may be regarded as due to the other winds than those from the west and south-west. Mr. Wallis is of opinion that the local relief of the Pennine Uplift gives to the cotton towns their characteristic climate, and is the dominant factor which has made Lancashire supreme in the cotton industry.

MICROSCOPY.

By F.R.M.S.

THE QUEKETT MICROSCOPICAL CLUB.—The five hundredth ordinary meeting of this well-known club took place on June 23rd, 1914, when, in the unavoidable absence of its President, the chair was occupied by Dr. E. J. Spitta, M.R.C.S., a Vice-President, and the President for four years, 1904 to 1907, who, in the course of a humorous speech, gave a brief summary of the history of the Society. It appears to have been originally suggested by a letter from Mr. W. Gibson, published in *Science Gossip* in May, 1865, in the course of which he expressed the opinion that a Society on similar lines to that of the established Society of Amateur Botanists was very desirable for amateur microscopists, and he therein outlined the basis upon which he thought it could be established. The idea was at once taken up by the then Editor, who invited correspondence on the subject from those persons desiring to join together for the purpose, and having consulted with his friends W. M. Bywater and Thomas Ketteringham a meeting of twelve gentlemen interested in the subject was called for June 14th, 1865, at the office of Mr. Robert Hardwicke in Piccadilly. Eleven of those summoned attended this meeting, and with Mr. M. C. Cooke in the chair decided, on the motion of Mr. Gibson, that a Society of the kind indicated was desirable. On the proposal of Mr. Edward Jaques, a provisional committee of five was appointed to consider the matter further. Mr. Bywater was nominated as Secretary, and the meeting was adjourned to July 7th at St. Martin's Schools, when about sixty gentlemen attended. It was then determined that the Club should be named after the late Professor Quekett, whose lamented death had occurred in 1861, and other recommendations of the provisional committee as to the dates of future meetings, the subscription to be paid by members, and the mode of conducting the business of the Club were discussed and passed, the meeting being adjourned to August 4th. This was also held at St. Martin's Schools, when eleven by-laws were duly passed and officers for the ensuing year were elected, Dr. Edwin Lankester being the first President, Mr. Bywater the Secretary, with Mr. Robert Hardwicke as Treasurer. The first ordinary meeting was held at the room in 32, Sackville Street, when the President delivered the inaugural address, and some of the newly elected members brought their microscopes and exhibited objects of interest. The Club continued to meet in Sackville Street until February, 1866, when, from the increase in the number of members, the room there became obviously too small, and permission was obtained for further meetings to be held in the Library of University College. From this small beginning the membership has increased to about four hundred and fifty, an extensive library has been formed, a cabinet of slides has been established, fortnightly excursions to promising localities in the neighbourhood of London have been arranged, and occasional dinners and soirées have been organised. Since its commencement in 1865 there have been twenty-two Presidents, holding office for from one to four years, of whom twelve are now deceased, and seven Secretaries. Of those members who were elected during the first year only seven now remain on the list, and of these two alone continue to attend the meetings, but the veteran Dr. M. C. Cooke, now in his eighty-ninth year, by a congratulatory letter sent to the last meeting still shows his unabated interest in the welfare of the Quekett Microscopical Club.

R. T. L.

II.—THE COMMON GNAT.—The life-history of the Gnat (*Culex pipiens*) is very simple, and is begun in the pools, ditches, and water which we have around our homes, especially in the country.

Still water, containing an abundance of decaying leaves and multitudinous forms of microscopic life, provides the most suitable breeding place for the insect.

The larva (see Figure 299) will be found in abundance near the edges of the water, hanging head downwards, with its tail end communicating with the air, wriggling about when disturbed, and sinking to the bottom at the slightest vibration.

It appears to be black in colour, and its length averages between half an inch to about three-quarters when fully grown.

The head of the larva is furnished with a large number of long and short hairs, mainly used for sweeping into its mouth the various animalculae within reach, upon which it feeds. On each side of the head are two prominent, tube-like outgrowths, which appear hollow, closed at the tip with a number of stiff hairs: these tubes later function as breathing organs in the pupal stage, but in the larva they are closed.

The large compound eyes, bulging out at each side of the head, are particularly noticeable, and these later become the organs of sight for the winged insect. The larva has no limbs, but its body is divided up into segments, eight in number, the last segment being specially developed for breathing, known as the *cylindrical respiratory syphon* (see Figure 300).

This syphon is traversed by two large air-tubes, which can be seen to pass backwards into the body and continue throughout its length to the head, thus all parts are supplied freely with air.

We now have the reason why the gnat larva, when at rest, suspends itself head downwards, so that the breathing tip of the tail is placed on the surface film of the water, and at the same time it can also feed.

By examining a mounted specimen in which the body of the larva has been made transparent, we can study the internal organs.

The alimentary canal commences with a long, narrow oesophagus, and this leads into the crop, or gizzard; behind we have the stomach, seen as a dark line extending about halfway through the body. The stomach leads into the intestine, and the Malpighian tubules open into the latter, acting as excretory organs.

The dark colouring of the stomach is due to the undigested particles of food, with earthy particles adhering to them, and digestion is carried out by the food previously masticated being passed slowly along and partially absorbed. The insoluble matter is then transferred to the intestine.

The breathing of the larva is effected by means of the spiracles situated at the end of the respiratory tube: these

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spiracles are guarded by three pointed flaps forming a valve, and, when closed, pierce the surface film of the water; when opened they form a cup-like depression in the surface film, from which the larva hangs.

Once a supply of air has been accumulated, the larva sets itself free from the surface film of the water and dives down, having previously closed its tracheal tube by means of the valve.*

It is interesting to know that the larva is slightly heavier than water; if it were lighter, then it is obvious the peculiar upside-down position would be impossible, for the body would then have to lie flat on the surface of the water. This is proved easily by disturbing the larvae when breathing, for they at once slowly sink to the bottom of the pool; but, after a very shot period, the journey upwards is commenced, and this is carried out by a series of jerking movements of the body, produced by the lashing of the tail appendages. Once the surface is reached, the larvae again suspend themselves upside down, remaining quite still, as found before being disturbed, the breathing process being continued. The explanation why it is possible for a body heavier than water to remain in the position in which Gnat larvae are found is rather interesting, and was solved by the joint experiments of Professors Miall and Stroud, under whom the writer studied at Leeds University.

The whole solution of this problem resulted in the explanation that the larva maintains itself at the surface of the water by taking advantage of the surface film, which overspreads the surfaces of all free liquids—*e.g.*, a steel needle floats on water for the same reason—and the Gnat larva is supported by the pull of the surface film on the pointed valves which open and close the air-tubes.†

The larva of the Gnat during this stage moults its skin for about three or four months, and then becomes ready for pupation form, and, further, by this time the parts necessary for the winged fly are in an advanced stage of development.

When the moult of the last larval skin has taken place, the new parts begin to assume their proper form and position, and in almost a few seconds the shape of the larva is at once changed into a pupa. The pupa is totally different from the larva both in size and habits, and really contains the fully formed fly, closely packed in a tight-fitting transparent skin, in which the winged form is kept a prisoner for a few days.

The pupa (see Figure 301) in shape resembles a comma, and, when found floating, the two ends are bent on themselves, with each point directed downwards. Its buoyancy is remarkable, owing to the internal parts being filled with large supplies of air, and when at rest it takes advantage of the surface film of the water, as in the case of the larva, only sinking when disturbed. The swollen head encloses the wings and legs of the fully formed fly, with compound eyes, mouth parts, antennae, etc.; each part has its own separate covering. The tail end is furnished with thin, flat hairy structures, and this enables the pupa to swim, controlling its direction. The position of the respiratory tubes has changed from the tail in the larval form, and now they are found on the head, one on each side, standing out like horns, or trumpets, thinner at their point of attachment than at the top.

These "air-trumpets" are placed in a position so that the broad ends can be embedded in the surface film of the water, and water is kept out by an arrangement of multitudinous hairs, which project from the inner walls of each trumpet. Air taken in by means of these trumpets is passed forward into the tracheal system, or air-tubes, of the body, and thus the latter is well supplied with air, which can be passed through all parts of the developing insect.

It is only natural that one would ask why the position of the respiratory intake has been changed from the tail of the larva to that of the head in the pupa, and this is easily understood when we find that the pupal form does not feed, and, further, that the emergence of the fully formed fly is effected by the splitting open of the swollen-head structure.

The winged insect, whilst it is enclosed in the head of the pupa, needs large supplies of air, and, consequently, the best position for the air-trumpets is in this region, which communicates direct with the supplies of air taken in.

The pupal stage lasts about three days in the summer, and when the skin ruptures along the thoracic region (on the back), and the Gnat begins to emerge gradually by drawing out its head, abdomen, wings, and legs, this process is performed by the body bending backwards till the whole insect has appeared (see Figure 303).

The time taken for this process is very short, and it requires a very quick eye to witness all the various movements as they take place, for no sooner has the Gnat fully emerged than a resting period of a few moments is taken by floating on the empty pupal skin until the wings dry, and then the insect sets off on its new existence (see Figure 305).

As in all other forms of insect life, we have in the Gnat two distinct sexes, male and female (♂ and ♀), and these distinctions are very marked, as will be seen later. The Gnat (♀) has its mouth parts specially constructed for sucking purposes, and, with the lancets, can pierce the skins of animals, drawing blood from the region attacked.

The parts performing this function (see Figure 302) consist of a long tube covered with hairs, and at the base are two lips, or lobes, which cover the hole in the skin of its victim in such a way that air cannot enter the tube when blood is being drawn from the wound.

Running alongside this tube, or *labium*, as it is better termed, we have the piercing organs, the ends of which are jagged like a saw: these piercers are the mandibles and maxillae, specially adapted, this explaining why they differ so much from the identical parts found in other insects.

The Gnat, when about to bite its victim, first plunges into the skin its mandibles and maxillae, making a round puncture. The labium is then applied to the hole made, and as the blood is drawn up through the labium the piercers are plunged further in to produce deeper penetration, and cover a larger area, from which more blood can be gathered into the labium.

As the process of sucking blood goes on, the head of the Gnat sinks lower and lower, till it almost touches the skin of its victim, and the labium becomes bent on itself, whilst the piercers are almost buried in the wound made. The body of the insect swells visibly as it becomes gorged with the blood of its victim, and it is well known that the female Gnat is a glutton for blood, especially the blood of human beings.

The reason why the female Gnat is so fond of blood is very difficult to explain, and certain theories have been advanced. One theory assumes that a supply of highly nutritive fluid is necessary for the sustenance of the insect previous to the laying of its eggs.‡

The sucking process is effected by the oesophagus becoming dilated, and this part acts as a sucking machine, for in front of the gullet is a minute valve which prevents the blood drawn up from escaping again through the labium. The enlargement of the oesophagus causes the internal pressure to become reduced, and the blood flows upward through the labium as seen in a syphon tube.

The antennae of the female Gnat (see Figure 306) are found one on each side of the head, springing directly from beneath the large compound eyes, and in structural detail differ very much from those present in the male.

They appear as jointed or stalked processes, having at each joint or node several stiff hairs, pointed at their extremities, and resemble very much the stem of a plant, especially the Horse-tails (*Equiseteum arvense*).

* "Life-Story of Insects," Carpenter, page 77.

† "Natural History of Aquatic Insects," Miall, pages 99-103; "Injurious and Useful Insects," Miall, page 126.

‡ "Natural History of Aquatic Insects," Miall, page 109.

FIGURE 299.

Larva of the Gnat (*Culex pipiens*).

FIGURE 300.

Breathing Tube of the Gnat larva, situated at the tail-end.

FIGURE 301.

Pupa of the Gnat.

FIGURE 302.

Head of the Gnat ♀, showing the labium, labial palps, mandibles, maxillae, and antennae.

FIGURE 303.

Winged insect emerging from the pupal skin halfway through the process of bending backwards.

FIGURE 304.

Head of the Gnat ♂, showing labium, maxillae, fused mandibles. The labial palps are absent.

XUM

FIGURE 305.

Female Gnat after emergence from the pupal skin.

FIGURE 307.

Part of a Gnat's wing, showing the "nerves" and hairs upon it.

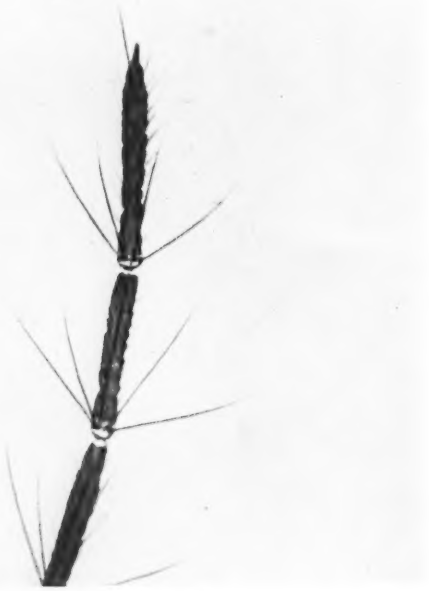

FIGURE 306.

Antennae of a Gnat ♀, showing the distal joints and the very few hairs.

FIGURE 308.

Antennae of the Gnat ♂, showing many of the joints and long projecting hairs.

The mouth parts of the ♂ Gnat (see Figure 304) are not as elaborately formed as those found in the ♀, and, in consequence, it is generally believed that the ♂ cannot bite in the same way, or draw up blood from animals; the mouth parts are very simple in structure.

If this is true (the question of the male being a vexed one), then no doubt its food is obtained in another way than by using its mouth parts. The mandibles and maxillae are fused into one piece; even the labium differs; and its sucking machine, the oesophagus, is undeveloped. It is a well-known fact that the female Gnats outnumber the males, and the latter are somewhat difficult to collect or even find. Perhaps this may be due to the district,* but information of this kind would be valuable for records.

The antennae of the male Gnat provide the main distinction between the sexes beyond that of biting, and the organs which are used for this purpose. In structure they are jointed as in the ♀, but the joints are shorter, and are fitted together in a different way (see Figure 308). At each node or joint are an enormous number of fine projecting hairs of much greater length than those found in the ♀, giving the antennae a bushy appearance, which can be readily detected by the naked eye. The large compound eyes are situated one on each side of the head, and bulge out prominently. They are made up of a large number of circular facets, hexagonal in shape, and it has been proved that those of the ♂ are considerably larger than the eyes of the ♀. This is generally the case in all male insects, and forms another link to the theory of evolution, the eyes of the male being constantly on the look-out for the female insect for pairing, and no doubt considerable distances have to be traversed for this purpose. It might be mentioned here that in exceptions the eyes of some insects are exactly the same size in both ♂ and ♀, but the ♂ insect has a larger number of facets developed.†

The ocelli, or simple eyes, found in insects and spiders generally, are absent through abortion in the case of the Gnat; further, the chitinous structure is very transparent, the pubescence is also bare, and the plates bend round the antennae.‡

The wings of both sexes are very similar, and appear as a marvellous revelation of beauty and structure for such a small insect, even when examined under a low magnification (see Figure 307).

On the outer portions of the edge nearest the body of the insect are innumerable short hairs, arranged in clusters, forming a heavy fringe, which commence from the tip of the wing, and are present only on this inner edge.

The veins or nervures of the wing are also covered with short thick hairs and scales, in form being broad on the top and pointed at the base, where they are attached in regular rows on each nerve or veinlet. These scales, it is interesting to note, resemble very closely those found on the wings of the various species of Lepidoptera, but they are of a much smaller size when comparisons are made.

W. HAROLD S. CHEAVIN, F.R.M.S.

(*To be continued.*)

PHOTOGRAPHY.

By EDGAR SENIOR.

PHOTO-MICROGRAPHY. ILLUMINATION OF OPAQUE OBJECTS UNDER LOW-POWER OBJECTIVES.—In our notes in the June issue of "KNOWLEDGE" we dealt with lower-power photo-micrography of objects that had not been specially prepared for the microscope, and we now give an example of this kind of work photographed with a Zeiss 100-millimetre planar, the object being a piece of American red gum wood split off from a block, and simply attached to a glass slip with plasticine. Obviously, as the specimen is opaque, it must be illuminated by reflected light, and there are a number of ways by which this may be easily accomplished and at the same time even illumination obtained over the entire surface. As this example was taken in illustrating to a class the various methods available for lighting objects of this nature, we cannot do better than repeat them. In the first place, as a considerable distance (4¼ inches) intervened between the objective and the object, there was plenty of room for any illuminating apparatus to be placed between them, and it was shown that by placing an optically worked disc of glass in such a position that it formed an angle of forty-five degrees with the axis of the lens that light reflected on to this disc by means of a plane mirror formed a means of illuminating the object perfectly, and that the reflected light transmitted by the objective enabled an image to be focused upon the screen that was both clearly defined and evenly lit. In employing this method, however, a strong illuminant is necessary, since the quantity of light that is reflected from glass only amounts to about four per cent. of that which falls upon it, so that in many cases the exposure required would be excessively long. This method of lighting has the advantage, however, that, owing to the light impinging on the object vertically, the structural detail will appear much finer in an object such as that shown in the photograph than it would do were the light to strike it more or less obliquely. When it is desired to obtain very strong illumination, then the transparent reflector is removed, and the plane mirror employed alone being placed at such an angle that the light is directly reflected from its surface on to that of the object, when, under these conditions, the image of the latter projected upon the screen will be found to be very bright, but at the same time much coarser in appearance, owing to the contrast produced by this method of lighting with objects having alternately raised and hollow surfaces. The appearance of the image, however, may be modified by rotating the stage upon which the specimen rests, as in this way the shadows will be modified according to the direction in which the light strikes the raised portions of the object. In the illustration (see Figure 293 on page 299) the lighting was further modified by using the plane side of a reflector attached to the body of the microscope to reflect the light on to the object, as this could be brought closer to the latter, the small mirror receiving its light from that reflected from the large plane one. By this method and careful adjustment of the apparatus generally, an image which was finer, and, at the same time well illuminated, was obtained. The photograph which is shown as an exampie was then taken, using an Imperial N.F. plate and a green light filter, the exposure given being five seconds, the lens having been stopped down to F/32, in order to obtain the necessary depth of definition. The dark portions, containing the gum, are well defined against the lighter parts of the woody fibre, and the result is an excellent example of what may be obtained by the method of illumination employed. When greater magnification is desired, and it becomes necessary to employ shorter focus lenses, then the object may be illuminated by means of a converging beam of light from a bull's-eye condenser, the illuminant being placed in front of the microscope stage, care being taken that the light shall impinge on the object as nearly as possible in a vertical direction, in order to obviate as much as possible the production of excessive shadows. In some cases, it may even be necessary to place a lamp and condenser on each side of the object in order to obtain the necessary freedom from heavy shadows. It must, however, not be forgotten that in many cases these shadows form the chief means of imparting the appearance of relief to the photograph, and so must not be entirely eliminated. When the distance between the various object planes is considerable, it will be found necessary to place

* The writer speaks of the North Country—Yorkshire, W.R.

† The Structure of the Eye Surface and Sexual Differences, *J.Q.M.C.*, Volume X, page 367.

‡ *Ibid.* Eye of Water-beetle, "KNOWLEDGE," Vol. XXXVII, page 225.

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a stop above the objective in order to increase its depth of definition, "or a piece of apparatus known as a Davis Shutter may be employed for the purpose." In photographing opaque objects the presence of a cover glass often gives rise to reflections which cause a great deal of trouble, and in many cases it is necessary to remove them before a satisfactory photograph can be obtained. Besides the methods already described for illuminating opaque objects, there are others which may be used that are found useful at times, such as that obtained by means of a parabolic silvered side reflector, or a piece of apparatus known as a "lieberkuhn." Their use, in many cases, however, is in no way superior to those previously explained.

DIAMOND JUBILEE OF *THE BRITISH JOURNAL OF PHOTOGRAPHY*.—With the issue of June 19th *The British Journal of Photography* celebrated its sixtieth year of continuous publication, and, in order to mark the event, presented to its readers a supplement containing a review of the progress of photography from the year 1839 to the present day, together with portraits of past and present editors of the journal, and also of early workers in the art, to whose labours the position now occupied by photography is largely due. The great developments which have taken place in photographic processes since the time when the action of light was first employed as a means for recording the forms of objects have in many cases been the result of contributions made to *The British Journal* by workers in the past, many of whom are no longer with us; and we often feel that the photographer of to-day scarcely realises the great debt which he owes to these early experimentalists for the generous spirit with which they made their discoveries known. The observations made with regard to the effects of light, even before photography was thought of, were very considerable; and to attempt to give even a brief record of the chief discoveries in photography from the earliest times would fill a volume of considerable size; while the work of such men as Eder, Abney, and Vogel would in itself be more than sufficient for any ordinary one. Then, apart from photography pure and simple, there are its many applications, chief among which are its use in the reproduction of colours in objects, photo-mechanical processes, and kinematography; and although a great deal of the experimental work that is being done in the applied science of photography is due to those who belong to countries other than our own, we are kept in touch with it through the medium of the photographic press, and, in particular, by *The British Journal of Photography*, which has always devoted itself to the interests of the professional photographer. And while we heartily congratulate the proprietors and editors on the attainment of the Diamond Jubilee of their paper, we trust that it may still continue in the same course of usefulness and interest that has marked its career in the past.

PHYSICS.

By J. H. VINCENT, M.A., D.Sc., A.R.C.Sc.

DEATH OF MR. THOMAS THORP.—It is with great sorrow that we learn from *Nature* of the death of Mr. Thomas Thorp, who originated the process of taking celluloid casts of ruled diffraction gratings. It is now fourteen or fifteen years since Thorp replicas began to be well known. They are now common in all laboratories over the world, and have proved a great boon to the amateur physicist. Before Mr. Thorp introduced his copies the only cheap diffraction gratings were produced by photography. These, however, usually on bichromated gelatine, were difficult to make, and the new process soon displaced the older methods of reproduction. It could be applied to the finest rulings, and gratings of high dispersion were thus rendered available where the cost of the originals made their purchase impossible. Mr. Thorp's inventive genius was active in several fields. He designed the first prepayment gas meter, discovered a method of protecting silvered telescope mirrors by a thin layer of varnish, and applied his gratings to colour photography.

UNIVERSITY APPOINTMENT.—Dr. Niels Bohr has been appointed Reader in Mathematical Physics in the University of Manchester. This brilliant young mathematical physicist leapt into fame by the publication of a series of remarkable papers on the constitution of atoms and molecules in the *Philosophical Magazine* last year. The fundamental idea of these papers is the mathematical treatment of a theoretical atom invented by Professor Rutherford to explain the results of experiments on the scattering of the α-rays by matter. These α-rays have been proved to consist of a flight of very rapidly moving material particles. Each particle is an atom of the rare gas helium, and differs from an ordinary atom of helium in that it is charged with two elementary units of positive electricity. When the α-rays, emitted by radio-active substances, are allowed to traverse matter, they suffer a scattering which, when studied quantitatively, suggested to Professor Rutherford that the atom must consist of a massive particle of very small size, with a positive electric charge round which revolve in orbital motion a number of electrons, or disembodied negative charges, of such a number as to make the total electric charge on the whole atom zero. The difficulty about this atom of Professor Rutherford was that the orthodox methods of mathematical analysis were incapable of dealing satisfactorily with the problems involved. Dr. Bohr got over this difficulty by using ideas imported from Planck's theory of radiation, according to which energy is itself regarded as consisting of indivisible quantities. The result was that he could calculate the size of atoms, explain the series of lines found in the spectra of some of the elements, and give a mathematical theory of the constitution of molecules.

THE ELECTRICAL RESISTANCE OF METALS AT LOW TEMPERATURES.—It has long been known that the resistance to the passage of the electrical current offered by a metal wire depends on the temperature. In the case of alloys the resistance may either decrease, increase, or remain stationary, when the temperature rises, according to the constituents of the alloy; but with the pure metals the laws of change of resistance with temperature are much simpler. In all cases the resistance falls when the metal is cooled. An extensive series of experiments on the resistance of pure metals between temperatures $-200°$ C. and $+200°$ C. was performed in 1892 and 1893 by Fleming and Dewar. The lowest fixed temperature employed was that of the boiling point of liquefied oxygen ($-182°{\cdot}5$ C.). From their results a chart was drawn showing the resistivity plotted as a function of the temperature for each metal. If the horizontal base line be marked out with temperature increasing to the right with the resistivity increasing upwards the general result of Fleming and Dewar's research may be stated as follows: The lines for all the metals are nearly straight, some being slightly convex, others slightly concave: they all slope downwards from right to left, so as to give the appearance that they would, if continued far enough, meet roughly at the temperature of absolute zero ($-273°$ C.) on the line of no resistivity. It seems, however, evident from Fleming and Dewar's curves that the lines do not converge to precisely the same point. The exact shape of the curves towards the lower ends is a matter of very great interest, and has been the subject of research in the renowned cryoscopic laboratory at Leyden by Professor Kamerlingh Onnes for some years. In 1911 he published some results of determinations of the resistance of Pt, Ag, Au, and Pb at the low temperatures attainable with liquid helium, and shortly afterwards began to study Hg. It was found that a mercury resistance which measured 172·7 ohms at 0° C. measured only ·084 ohm at 4°·3 absolute, while at 3° absolute it was less than three millionths of an ohm. It thus appeared that, contrary to what had been expected, the resistivity curve dropped suddenly down on to the line of no resistance before the

metal had been cooled to absolute zero. Subsequently (1913) it was found that this collapse in the resistance occurred within a fall of temperature of about ·02 degree beginning at 4°·21 absolute. When the temperature was lowered to 2°·45 absolute the resistance was less than a twenty thousand millionth of that at 0° C., while with a potential difference of ·56 microvolt on the ends of the mercury thread the current density was over a thousand amperes per square millimetre. It was also found that similar results occurred at these low temperatures in the case of tin. On June 29th, 1914, Professor Onnes communicated to the French Academy some further results, in which the effects are found in lead, and in which experiments of a very striking character are recorded. The almost total loss of resistance occurs in the case of lead at a slightly higher temperature then in the case of the metals previously investigated. Thus a coil of pure lead which had a resistance of seven hundred and thirty-six ohms at ordinary temperatures became practically resistance-less at the temperature of liquid helium, so that a current of electricity set circulating in it by induction continued to flow for some hours sensibly undiminished in strength. The lay press has been aroused to an interest in the subject by these experiments. It is quite possible that one of the results of these researches will be to supply a method of obtaining very intense magnetic fields. The limits imposed by resistance are the chief difficulties met with in designing apparatus such as powerful electro-magnets. Professor Perrin proposed some time ago to use coils placed in liquid air for obtaining high magnetic fields. Even here, however, the power required turns out to be very high. If, however, the coils could be robbed of their resistance by liquid helium, it looks as if the attainment of magnetic fields of immense strength would be rendered feasible.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

RESPIRATION IN WATER-BEETLES.—It is usually stated that insects drive the air out of their tracheae by the contraction of expiratory muscles situated in the abdomen, and that inspiration is passive. Frank Brocher has convinced himself that this statement is not always true. In Water-beetles of the well-known genera *Hydrophilus* and *Dytiscus* the chief respiratory movements are localised in the metathorax, not in the abdomen. In *Hydrophilus* inspiration appears to be as active as expiration, and the muscles concerned in the inspiration are the stronger.

TERNS PLUNGING BELOW THE SURFACE.—Most observers are agreed that Terns usually pick up their food from the surface of the water, but Mr. W. Bickerton records seeing " the underwater plunge " on the part of the Sandwich Tern, the Common Tern, the Arctic Tern, and the Lesser Tern. The Lesser Tern, closely followed by the Arctic Tern, is most addicted to plunging. Mr. Bickerton's observation is confirmed by Messrs. Headley and Oldham as regards the Common Tern. It is not asserted, however, that feeding from the surface of the water is not the rule. The point is one of considerable importance in connection with the case brought against Terns as destroyers of fry.

WEIGHT-LIFTING POWER OF WASPS.—In enlarging the underground nests, which some kinds of social Wasps make, it is often necessary to make excavations, and obstacles met with must be removed or allowed to accumulate on the floor of the cavity. Mr. Charles Oldham has watched Wasps (*Vespa germanica*) removing pieces of chalk and flint, and flying off with them in their mandibles. A talus of fragments was observed near the nest, and the average weight (·347 gramme) was more than 4·5 times the average weight of the Wasps (·076 gramme). The insects always tried to fly, but the flight was sometimes very short and laboured. Similar observations were made in regard to *V. vulgaris*: it was found that individuals of this species carried fragments of stone nearly four times their own weight. Even if a Wasp plies its wings at the rate of one hundred and ten beats per second, its ability to carry stones about four times its own weight is very remarkable, and, as the observer points out, is far more than any bird can do.

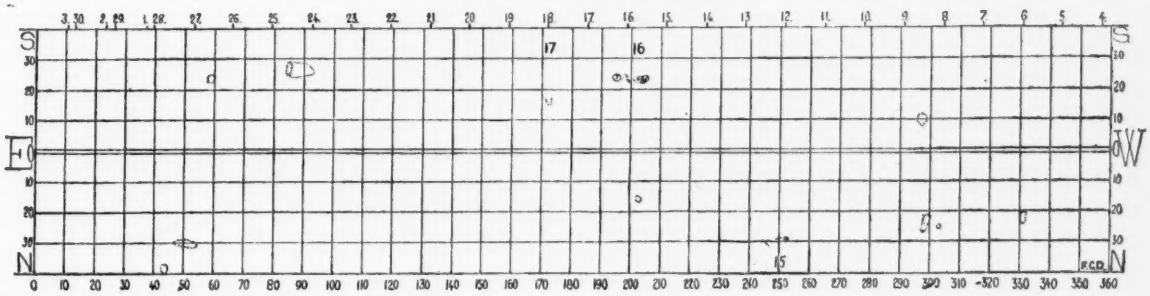
SOLAR DISTURBANCES DURING JUNE, 1914.

By FRANK C. DENNETT.

THE Sun was under observation every day during the month, but only on three occasions (2nd, 23rd, and 28th) appeared quite free from disturbance, but on twelve others (1st, 3rd to 7th, 24th to 27th, 29th, and 30th) only faculae were visible. Spots were seen on the remaining fifteen days. The longitude of the Central Meridian at noon on June 1st was 36° 53′.

No. 15.—On the 7th a faculic disturbance was seen well round the north-eastern limb extending from latitude 26° to 34°, brightest in the equatorial half. On the 8th it contained two larger and two smaller pores. During its visibility the leader increased to seven thousand miles in diameter, and the group attained a length of forty-nine thousand miles. It was largest on the 10th, and then dwindled until last seen as minute pores on the 15th, the area remaining faculic until the limb was reached on the 18th.

DAY OF JUNE, 1914.



No. 16.—On the 12th a triangle of three pores had developed in the south-eastern quadrant. The group lengthened to seventy-seven thousand miles. The western spot was twelve thousand miles across on the 15h. The maximum area of its members was reached on the 18th, when the trailer had reached a diameter of twenty-two thousand miles, whilst the leader had penumbral extensions to quite twenty-seven thousand miles. It was last seen on the 22nd, when there was a big spot reduced to a narrow line close within the limb, and followed by faculae.

No. 17.—A faculic area seen a little north-east of No. 16 on the 12th. Next day a pair of pores showed. On the 13th there were six pores visible. On the 14th a spotlet with two tiny pores to the west. The spotlet alone remained on the 15th and 16th. On the 17th there were two minute pores, and on the 18th two differently placed, but not seen after. The faculic remains were visible on the 22nd.

Faculae were recorded near the western limb on the 3rd and 14th. Near the north-western limb on the 5th and 6th (longitude 54°, N. latitude 30°), 24th and 27th. Near the north-eastern limb on 1st, 3rd, 4th (longitude 300°, N. latitude 26°), 10th and 11th (longitude 202°, N. latitude 16°), 13th and 24th (longitude 43°, N. latitude 38°), 25th and 27th (longitude 331°, N. latitude 22°). Near the eastern limb on the 3rd and 4th (longitude 297°, S. latitude 10°). Near the south-western limb on the 4th and 5th (longitude 59°, S. latitude 23°), 10th, 11th, 26th, 29th, and 30th (longitude 86°, S. latitude 28°). Within the south-eastern limb on the 10th and 12th. And also near the North Pole on the 27th.

Our Chart is constructed from the combined observations of Messrs. John McHarg, J. C. Simpson, W. H. Izzard, E. E. Peacock, and the writer.

REVIEWS.

ASTRONOMY.

An Introduction to Celestial Mechanics.—By FOREST RAY MOULTON, PH.D. Second revised edition. 437 pages. 62 illustrations. 8¾-in. × 5¾-in.

(Macmillan & Co. Price 15/- net.)

There are many students who have mastered the easier parts of the Differential and Integral Calculi, and who desire to apply the powers thus acquired to the understanding of the celestial motions. They could not select a better book for their purpose than the present volume. A large portion of it would be easily within their grasp. It contains all the introductory matter on forces, accelerations, and laws of motion, so that it is complete in itself, and needs no accompanying textbook on Dynamics. It contains many interesting physical digressions, such as the escape of planetary atmospheres, and the meteoric and contraction theories of solar energy. There is also a study of the question whether the observed orbits of double stars furnish a proof of the existence of gravitation in these systems. This cannot be proved with mathematical precision from the observed facts, but it is shown to be a moral certainty. An explanation is given of the graphical solution of Kepler's problem by means of a sine-curve, which is very useful in the case of orbits of large eccentricity. There is also an introduction to the method of development of functions in series of sine-terms.

Attention will naturally be turned to the chapter on the Determination of Orbits, for since Watson's "Theoretical Astronomy" has gone out of print there has been a dearth of works in English dealing with this subject. The author's treatment of it is mainly from a theoretical standpoint, and scarcely full enough to be clear to the beginner, who also needs some actual numerical examples to be fully worked out. Still, all will enjoy the chapter as a lucid and orderly presentment of the various methods: it includes Professor Charlier's recent results on the regions where there are two orbits satisfying the three observations, and those where there is only one.

The following chapters give an outline of the planetary motions, and a discussion of easier cases of the problem of three bodies, including the five exact solutions. One of these is the Straight Line solution; its possible connection with the phenomenon of the Gegenschein is discussed; it is not stable motion, so no particular particle could remain long in the required position, but if the supply of meteoric matter is sufficient, new particles might continually replace those that moved away. Another interesting case is the equilateral triangle solution; practical examples are now known in the solar system, viz., the Trojan group of Asteroids, which make an equilateral triangle with the Sun and Jupiter. The criterion for stability is shown to be that the mass of the perturbing planet should not exceed ·0385. As the mass of Jupiter is only one-fortieth of this limit the motion of these asteroids is stable.

The final chapters give both geometrical and analytical explanations of the more interesting perturbations of the Moon and planets: the method of mechanical quadratures is briefly explained, and its advantages and disadvantages, compared with the method of expansion in series of sine-terms, are pointed out. The book closes with some general reflections, the final sentence being: "As the telescope has brought within the range of the eye of man the wonders of an enormous space, so Celestial Mechanics has brought within reach of his reason the no lesser wonders of a correspondingly enormous time. It is not to be marvelled at that he finds profound satisfaction in a domain where he is largely freed from the restrictions of both space and time."

A. C. D. CROMMELIN.

BIOLOGY.

The Country Month by Month.—By J. A. OWEN and G. S. BOULGER. 492 pages. 32 illustrations, of which 12 are in colour. 9-in. × 6-in.

(Duckworth & Co. Price 6/- net.)

The interest which is taken in Field Natural History and the usefulness of the book before us are shown by the fact that the latter, since its publication in 1901, has been reissued, and now appears again in a new edition with coloured plates. Mrs. Jean A. Owen, who edited the well-known series of books by "A Son of the Marshes," is responsible for the chats on Birds and other Vertebrates, while Professor Boulger contributes the chapters dealing with Plants and Insects. Furthermore, the late Lord Lilford, on reading the first edition, made a number of interesting comments with the idea that they might be incorporated in a second; and these have now been added, with the result that still another interest is given to the book. To those who are not familiar with it we would say that, as its title suggests, it gives an account of the changing face of the country, and its wild life, in the form of a regular calendar of the seasons, and we commend it to lovers of nature who need some guidance, or who wish to be reminded of what they may expect to see at various times of the year. It is far, however, from being a mere category. Incidentally all kinds of facts, anecdotes, and theories, not to mention poetic extracts, are introduced, which make it worthy of a place in the literature of the country.

W. M. W.

CHEMISTRY.

The Simpler Natural Bases.—By G. BARGER, M.A., D.Sc. 215 pages. 9¼-in. × 6-in.

(Longmans, Green & Co. Price 6/- net.)

This latest addition to the series of Monographs on Biochemistry deals with those groups of nitrogenous compounds in animals and plants, which are of a basic nature, but have a more simple structure than the alkaloids. They

include the amino compounds to which Brieger gave the name of "ptomaines," produced in the putrefaction of proteins; creatinine, and the other meat bases; and the curious base adrenaline, which occurs mainly in the suprarenal gland. The distribution, constitution, and chemical and physical properties of these bodies are fully dealt with, and there is also a good outline of the physiological properties of adrenaline and the ptomaines. Practical methods of isolating and identifying the different bases and a description of their principal salts are given in an appendix, the sections of which correspond to the different chapters in the book. As in the case of the other monographs in this series, there is an excellent classified bibliography, and the book should meet with a warm welcome from every biologist and chemist whose work is concerned with food products.

C. A. M.

Elements of Qualitative Chemical Analysis.—By J. STIEGLITZ. 2 vols. 312 and 153 pages. 8¾-in. × 6-in.

(G. Bell & Sons. Price 6/- each volume.)

The two volumes of this book embody the author's experience as a teacher of chemistry, and are an amplification of the lectures given by him during the past sixteen years. In the first volume the fundamental chemical theories of osmotic pressure, ionisation, chemical and physical equilibrium, and so on, are discussed, and their application in qualitative analysis is clearly shown, although, for the most part, the use of physico-chemical methods is restricted within the limits implied by the title. In the second volume the group reactions are systematically studied, and an outline is given of a course of qualitative analysis, which is mainly confined to inorganic substances. Throughout the book stress is rightly laid upon the importance of keeping a quantitative point of view in mind, and Professor Stieglitz appears to share the view of many teachers of chemistry that qualitative chemistry should be made quantitative. The two volumes are intended to be used together, and the student who has mastered them cannot fail to be an expert analyst.

C. A. M.

ECONOMICS.

The Government of Man: an Introduction to Ethics and Politics.—By G. S. BRETT, M.A. (Oxon). 318 pages. 7¼-in. × 4¾-in.

(G. Bell & Sons. Price 3/6 net.)

As Mr. Brett remarks in his Preface, "The study of ethical theories is too often conducted with no immediate reference to the historical setting of each theory; even political science is often divorced from the events which gave vitality to the theories; and every experienced teacher knows the practical difficulty of supplying a background for the continuous development of theories." His book is an attempt—a very successful attempt on the whole, I think—to cope with that difficulty; but it is not intended to be a history of politics, ethics, or economics.

In the first part, occupying about half the volume, the theories and practice of the ancient world are discussed, where that term is taken to mean Greece and Rome; the second part deals with the mediaeval period in Europe; while the third brings us up to the time of John Stuart Mill.

The chief criticism that may be passed is that the discussion is too restricted in a geographical sense. There were ancient systems of civilisation other than those of Greece and Rome; and in dealing with the modern period the author restricts himself almost entirely to English writers on ethics and politics.

But the book contains much that is interesting and stimulating to thought. As the author points out, the family forms the unit of all primitive organisations. "No one thing in the history of the world," he says, "has had more effect than the natural overlapping of the generations." Here we can find the origin of the concept of kingship; but the primitive king almost inevitably degenerates from a father to a tyrant, as his family grows until it is no longer a true family.

As the author shows, although the nobility of Europe did something to foster noble ideals of loyalty and high breeding, "there has never been a more fruitful source of corruption than hereditary titles and positions; for the control of others has too often descended by right of birth to those who had never learnt to control themselves"; and, as he points out, a form of republicanism "seems to be the inevitable consequence of progress and enlightenment."

The history of the government of man is a curious and, in a way, a tragic history. We can see the conflict between the concept of government as power and the concept of government as an applied science. Plato, in his immortal work, has formulated the latter idea, and it is once more coming to the fore. But, as ever in this history, practice lags behind theory. We may see, too, the conflict of reason with prejudice and convention. The ethical and political writers of the eighteenth and early nineteenth centuries represent reason in its least satisfactory aspect. They forget the existence and power of the emotions. It would not be fair, however, to say this of Mill, whose views, one gathers, have Mr. Brett's support. Had Mill only realised the true significance of religion, he might well have formulated a completely satisfactory theory of ethics.

Mr. Brett claims to have written without bias, and, on the whole, I think he has done this, though, as I have said, one can tell where his sympathies lie. It is regrettable, I think, in view of the general misunderstanding of that word, that he should have referred to Rome's system of feeding its unemployed wastrels at the expense of industrious provincials as "a vast system of State Socialism." But, not to end on a note of criticism, let me finish by quoting from the book an altogether excellent passage, relating to the views of the Utilitarian school: "To take pleasures and pains as the basis for measuring social progress is to cast away the 'indefeasible rights,' which were obviously producing and increasing the misery of the people. To assert that every man should count for one, and one only, is to recognise that in a free country there must be freedom of opportunity and of action, limited only by the existence of a majority that opposes the action."

H. S. REDGROVE.

PHYSICAL CHEMISTRY.

The Viscosity of Liquids.—By A. E. DUNSTAN and F. B. THOLE. 91 pages. 12 figures. 62 tables. 8¾-in. × 6-in.

(Longmans, Green & Co. Price 3/- net.)

This book is one of a series of monographs on Inorganic and Physical Chemistry issued by the above publishers under the editorship of Dr. Alexander Findlay. The avowed aim of this series is to assist students preparing for an Honours Degree or those undertaking research, and the present book is written in conformity with this design. The authors have culled information on the subject of viscosity from no fewer than one hundred and thirty-six published papers—to which full references are given—and have succeeded in placing before the reader a comprehensive view of the present state of our knowledge regarding the viscosities of liquids. The readers for whom the book is intended may, in consequence, make themselves acquainted with the various aspects of the subject, without having to spend a considerable amount of time in searching for information scattered through the pages of various scientific journals, and will therefore find the book of great assistance.

Allowing for the somewhat narrow audience the book is intended to reach, there are few criticisms to offer. The abbreviated heading of the right-hand pages of Chapter IV—"Viscosity of Pure Liquids subsequent to 1895"—is ambiguous, and might be better worded. In most of the graphs no numerical values are assigned to the coördinates, although points representing actual observations are of frequent occurrence. The result of this is to render the

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graphs qualitative only, when a slight addition would have enabled quantitative values to be read also, and the checking of the results of new experiments against previous figures thus facilitated. This omission is probably due to the fact that the view of the book is comprehensive rather than detailed.

The book contains nine chapters, the first of which is devoted to formulae; the second to experimental methods; the third and the fourth to the values obtained by various workers for the viscosities of pure liquids; the fifth to liquid mixtures; the sixth to electrolytic solutions; the seventh to colloids; the eighth to the relation between viscosity and chemical constitution; and the ninth to special applications of viscosity. Many interesting relations between the viscosities of allied chemical compounds are brought out, and the importance of viscosity as an aid to the elucidation of chemical problems clearly established.

From the standpoint of the general reader, the restricted scope of the book is a drawback. It can only be read with advantage by those who already possess a clear conception of the meaning of viscosity and a fairly advanced knowledge of chemistry. Little mention is made of the use of viscosity tests for commercial purposes, the test devised by Schidrowitz for the evaluation of rubber being the only one referred to. Such an important question as the viscosity of lubricating oils does not find a place in the book, although, from the standpoint of the average chemist, a knowledge of this branch of the subject is at least equal in value to that of the viscosities of a series of organic compounds. It must be remembered, however, that the book has been written for special, and not for general, readers; but so well have the authors achieved the limited task allotted to them that one cannot but regret that the occasion did not permit them to produce a volume of a more general character, and adapted to a wider circle of readers.

CHAS. R. DARLING.

NOTICES.

MR. MURRAY'S QUARTERLY LIST.—Among the forthcoming works in Mr. Murray's Quarterly List we notice the following, which are of particular interest to our readers: "Trees and Shrubs hardy in the British Isles," by W. J. Bean; "Life Histories of African Game Animals," by Theodore Roosevelt and Edmund Heller; "Practical Tropical Sanitation," by W. Alex. Muirhead; "Hunting Pygmies," by William Edgar Geil; and the ninth edition of Fream's "Elements of Agriculture," edited by J. R. Ainsworth-Davis.

THE MARTIN KELLOGG FELLOWSHIP.—*The Evening Post* (New Zealand) says that a distinction is conferred upon New Zealand by the awarding of a Martin Kellogg Fellowship in the Lick Astronomical Department of the University of California to the Government Astronomer, Mr. C. E. Adams, M.Sc., F.R.A.S. The fellowship was endowed by Mrs. Louise W. B. Kellogg in memory of her husband, Martin Kellogg, whose services in the University of California, as professor and president, covered nearly half a century. The purpose of the fellowship is to provide opportunities for advanced instruction, and for research, to students who have already received the degree of Doctor of Philosophy, or an equivalent, or to members of staffs of observatories. The Lick Observatory, situated on top of Mount Hamilton, California, is probably the best-known observatory in the world. It was founded in 1876 under the will of Mr. James Lick, a Californian millionaire, and in 1888 was transferred to the University of California. It is splendidly equipped with instruments of astronomy, and in investigational work has been exceedingly fruitful. It is estimated that the instruments on Mount Hamilton are from two to five times as fruitful and efficient as those of similar observatories under ordinary climatic and local conditions. A large proportion of the principal astronomical discoveries of the last quarter of a century has been made at the Lick Observatory.

THE CAWTHRON SOLAR OBSERVATORY.—The President of the Wellington Philosophical Society, Dr. C. Monro Hector, recently gave an address, which is reported in the *Evening Post* (New Zealand), to the members of the Society on the subject of the establishment of the Cawthron Solar Observatory at Nelson. After alluding to the good work done by Miss Mary Proctor, the munificent gift of Mr. Thomas Cawthron, of Nelson, and to the report furnished by Mr. Evershed (in charge of the Kodaikanal Solar Observatory in India) on the proposed sites at Nelson, Dr. Hector summarised the present position in regard to the observatory as follows:—

(1) The establishment of a solar observatory in New Zealand has the cordial approval of the leading authorities in Europe and America, and offer of all possible assistance from the Royal Astronomical Association.

(2) Meteorologically the neighbourhood of Nelson is suitable. The records show that it has twenty per cent. more sunshine and thirty-three per cent. less rain than at Kodaikanal Solar Observatory, in India.

(3) Several excellent sites are available within a short distance of Nelson.

(4) Examination of these sites by a recognised expert has shown that the conditions are excellent for solar work.

(5) Of the sites available, that on the Port Hills, within easy reach of the town, has so far proved the best from an observatorial point of view.

(6) The adoption of this site will mean an enormous saving in initial outlay and running expenses.

(7) The estimated minimum sum required to establish an observatory competent to give continuous service equivalent to that of northern observatories is £30,000.

(8) Mr. Thomas Cawthron has promised to give £30,000 for a beginning.

(9) A suggested deed of trust has been drawn up, and a suggested Board of Trustees has been submitted to Mr. Cawthron for his approval.

(10) Mr. Cawthron has generally expressed his approval of the above.

In the picture of the approved site, the location is shown on the hill at the rear side of the Boys' College, and Dr. Hector stated that it is in close proximity to the new Queen's Drive that Mr. Cawthron is presenting to the city of Nelson.

The proposed constitution of the Board of Trustees of the Cawthron Observatory is as follows:—Mr. Thomas Cawthron, one member nominated by each of the following bodies: Nelson Philosophical Institute, Board of Governors of the Nelson College, Nelson City Council, New Zealand Institute, the Council and Professorial Board of Victoria College (acting together), University of New Zealand, the Council of the Astronomical Section of the Wellington Philosophical Society, the Surveyors' Board, the Government Astronomer, *ex officio*, and two others to be elected by the rest of the board.